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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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Forthcoming Events.

Institute of British Foundrymen.

JUNE 17-20.

Annual Convention at Middlesbrough.

JUNE 28.

Lancashire Branch :—Visit to the works of Messrs. Clay Cross Company, Limited.

Optimism.

We referred in these columns recently to that "studied pessimism" which has come to be regarded as a British characteristic, and we expressed in passing some regret that this should be so. Regret, however, is an expression hardly adequate to the circumstance. In social and political life the tendency to be gloomy at the slightest provocation matters very little: there is always a noisy minority that must be "again the Government," and in default of unemployment, the income tax, or a housing shortage, there would always be something else to grumble about. In business and industrial life, however, the same tendency matters enormously: it matters in the first place because it militates against trade revival and expansion at home, and in the second place because it interferes with business abroad.

We in industry are not commonly concerned with psychology and its effects: we deal in hard facts. Yet in the present instance it is the psychological effect that is important. A distinguished modern writer says: "An expansion of business confidence propagates itself by that sympathetic and epidemic excitement which largely sways communities of men," and he adds: "This tendency is the more marked in so far as business men are congregated in close physical proximity to one another." In everyday language, the man who is hesitating to place an order will often make up his mind to go ahead because he has been out to lunch and heard his friends talking about the orders coming in—and especially as men engaged in the same trade tend to group themselves in certain convenient localities. The society of our fellows has, whether we like it or not, immense influence on our actions. If our friends are gloomy, how can we help being gloomy? If we are gloomy, how can our typists, our foremen, our moulders, help being gloomy? And so the evil spreads, and the whole community hesitates to buy, hesitates to invest, hesitates to do any of those things that are vital to trade revival and prosperity.

The effect of British pessimism on the foreigner has been dealt with in several quarters recently, but it cannot be over-emphasised. It is our habit to tell the world all about our troubles—our unemployment, our obsolete plant, our poor salesmanship. To use a colloquialism, we wash our dirty linen in public. We do not stop to consider that actually our unemployment is less serious than Germany's, or America's; our plant manned by the most intelligent and skilled workers in the world, our goods true to a tradition of quality and reliability. Nor do we stop to consider that what we say will be read and discussed all over the world, that it will create an unfavourable impression, a lack of confidence and a hesitation to do business.

What, then, is to be done? We have our troubles, and no one can spirit them away: we have the habit of talking about them, and no one can cure us overnight. But can we not give a little more attention to the other side of the picture?—talk of the orders we have received instead of the ones that have failed us; talk of our rising standard of living and our extensive social services instead of the burden of unemployment; talk of our skilled workers, our high-quality goods, our sound reputation, instead of our obsolete plant and our out-of-date salesmanship. Here is something that every single individual can do, whether in a public or a private capacity, to forward trade revival, and it is to create a state of optimism instead of a state of pessimism. Let us, in fact, count our blessings—and count them aloud.

Inherent Properties and a Nucleus Theory.

We were always somewhat intrigued by the theory that inherently bad or good properties of pig-iron which could be reproduced in the finished casting could be ascribed to the non- or complete solution of graphite nuclei during remelting. The graphite flakes existing in pig-iron are probably not as large as the grains of animal charcoal used for the cementation of armour plate. At a temperature well below that existing in the cupola, the carbon is taken up by steel and a penetration up to 3 in. or more is effected, yet the structure is non-graphitic. Another thought on the same subject is that we feel reasonably sure that if a crucible containing a mixture of alloys necessary for making high-speed steel were placed in the melting zone of a cupola and surrounded by a good-class coke, and the furnace were fired normally, complete fusion would be effected. Naturally, the time element would have to be taken into consideration, as high-speed steel has a very high melting temperature. The supporters of graphite nuclei theory regard this as one of their cardinal points—that is, the iron is melted so rapidly that a quantity of the nuclei has no opportunity of getting into solution. Personally, we are inclined to rule out melting temperature as a factor, but we still regard the "time" factor as of paramount importance. Mr. Allison elsewhere in this issue puts forward some evidence to indicate that manganese sulphide and not graphite can form centres favourable for the precipitation of graphite of the coarse variety. If we interpret Mr. Allison's work correctly, we gather that, whilst not denying *in toto* the correctness of the nucleus theory as previously enunciated, he feels that the presence of foreign bodies in general, and manganese sulphide in particular, must also be given adequate consideration. We attach the greatest importance to *a* nucleus, but at the present state of the investigations into the subject only accord

limited support to *the* nucleus theory. With really "kishy" irons, *the* theory probably holds good, but in cases where the graphite should by all rules and regulations be reasonably easily soluble, one must envisage that the dirty black graphite flakes possess in their interior a germ of extraneous and less soluble material which induces its early precipitation.

Sports Ground for Foundrymen.

Messrs. J. Stone & Company, Limited, the well-known engineers and non-ferrous founders, of Deptford, London, S.E.8, and Charlton, S.E.7, have recently provided for their employees a new sports ground at Charlton.

Facilities for cricket, tennis, bowls, Association and Rugby football, and hockey will be afforded, and our illustration shows the pavilion, which is a spacious and well-constructed building with ample shelter and accommodation.

The ground was opened by Sir Frederick Preston, K.B.E., chairman of the company, who addressed the gathering and performed the opening ceremony of hoisting the club colours.

The Pavilion of the New Sports Ground of Messrs. J. Stone & Company, Limited, Deptford.

It is interesting to note that Mr. Wesley Lambert, the President of the Institute of British Foundrymen, is associated with the company in the capacity of chief metallurgist.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Wheel-Moulding Machine.

To the Editor of The Foundry Trade Journal.

Sir,—Referring to Mr. Sutcliffe's article on page 382 of your issue of May 22, 1930, we note he gives as his reason for making a 12 ft. dia. wheel in the floor was because the largest table machine is only capable of making a wheel 7 ft. dia. This may apply to the machines in their foundry, but we wish to point out that we make a standard machine capable of moulding up to 12 ft. dia. This machine would have obviated and rendered unnecessary the extra work which was encountered by Mr. Sutcliffe.—Yours, etc.,

F. C. Demaine,
Foundry Manager,
Buckley & Taylor, Limited.

Castle Iron Works, Oldham,
June 3, 1930.

Founder Lectures to Rotary Club.

Mr. J. M. Primrose, manager of the Grangemouth Iron Company, Limited, Falkirk, addressed the members of the Falkirk Rotary Club at the weekly luncheon on Thursday, May 29, on "A Day in the Foundry." In the course of his address, Mr. Primrose said that he did not feel competent to prophesy regarding the future of the light-castings industry, but they could let it take care of itself. Moulding was a very old industry, and man, with all his various requirements, could not live without the foundry. Castings were despatched from Falkirk by road, rail and sea to all parts of the world. Certain pessimistic persons would have them believe that the foundry industry in Falkirk was suffering from a dreaded senile decay, but he confidently predicted that, through the rationalisation which was going on amongst the principal foundries, there was a brighter and more prosperous time ahead of them. It was stated that work was going to the Midlands of England—Falkirk's finished work was certainly going to the Black Country. So far as light castings were concerned, the whole world had learned this job from Falkirk, and he asked them to take his word for it when he said that there was a great deal more to learn. The moulder's trade was so intricate and there were so many branches of it that even men who had been in the moulding shop for 50 years were still finding that they had something to learn. Mr. Primrose described in considerable detail the work of a foundry, tracing the progress of raw material to the finished product. The members then visited the Grangemouth Foundry, where they saw the various stages of manufacture in progress. At the conclusion of the visit the members were entertained to tea and light refreshments in the foundry welfare department. On the call of the President, Mr. Primrose was heartily thanked for his interesting exposition and hospitality.

The Vanadium-Carbon System.—The vanadium-carbon system has been investigated by Messrs. Atomi Osawa and Masakichi Oya by microscopic observation and X-ray analysis, and a probable diagram proposed. According to the authors, in this system there exist three phases, alpha, beta and epsilon, the latter two corresponding to compounds V_2C and V_4C_3 with a solubility. The crystal form of the former compound is hexagonal, having an axial ratio of 1.59, and the atomic distribution is hexagonal close-packed.

Random Shots.

The week's mails have brought me large quantities of literature from the American Foundrymen's Association Convention at Cleveland. There is always plenty of entertainment to be got out of this literature, more especially that part of it which takes the form of a daily paper issued while the Convention is in progress. This particular enterprise always impresses me, and I have wondered before now why we do not do anything of the sort over here. But when I discovered that, by the third day of the Cleveland Convention, 4,300 people had registered, I decided not to waste any more time wondering! (What I am wondering now is how Mr. Makemson would enjoy arranging an I.B.F. Convention for 4,300 people? I fancy it might be rather a strain on Middlesbrough's hotels!)

* * *

Of course, the drawings, somewhat embryonic strip comics in character, contain most of the intentional humour, but the general make-up and appearance of the paper has its amusing side, too. And I must admit to a certain puzzled disapproval of paragraphs headed "Entertain Members and Guests," "Operating Ovens Display Features," and so on. I suppose their chief merit is that they force you to read the paragraph if you want to find out who or what entertains members and whether the ovens are displaying their features or the display featuring ovens.

* * *

These same papers brought me news of the activities of Mr. J. G. Pearce, of the Cast Iron Research Association, for he is referred to quite a number of times—as presenting the I.B.F. Exchange Paper, as speaking at a luncheon, as having visited incredible numbers of foundry centres in a "pre-Convention tour." And there is one delightful bit that I must quote, in order to show that the I.B.F. this year selected a worthy representative of their best traditions. It is headed "Englishman Knows How," and it says that Mr. Pearce "did not waste all his young life grubbing into the mysteries of metallurgy. According to competent lady observers, he shakes a pair of wicked hoofs when the saxophones and oboes go Oo-Ah or what have you."

* * *

I also have news of a lively reunion held during the Convention, at which 64 members of the parties that visited Europe in 1923 and 1929 met and dined on a boat in dock, in what seems to have been a highly successful imitation of a gala night at sea. Not the least amusing part of the show was the elaborate circular announcing the affair, on the lines of the usual tourist agency programme. "If you left your wife (husband) at home," it says, "don't do so this time. Bring her (him) along, but the children couldn't stand the trip, so better leave them at home."

* * *

It was a particularly graceful thought on the part of this convivial gathering to send a cable to Mr. and Mrs. Wesley Lambert, and further testimony, were any needed, of our last year's visitors' appreciation of their kindness, both personal and official. The cable ran:—"American overseas recipients your hospitality twenty-three and twenty-nine in happy party toast Lamberts." The creation of this kind of lasting goodwill and friendship as between one country and another seems to me to be one of the most valuable achievements of the I.B.F. Conventions. In this case enthusiasm was such that an invitation was extended to any available Englishman, and I believe there was a good deal of disappointment because Mr. J. T. Goodwin's travels did not allow him to reach Cleveland until the following day.

Marksman.

The Correlation of Mechanical Tests for Cast Iron.*

By J. G. Pearce, M.Sc.

[BRITISH EXCHANGE PAPER.]

Introduction.

The problem of adequate tests for cast iron is, perhaps, the greatest of the many that the foundry metallurgist has to face; it lies at the root not only of the buying and selling of castings, and of the control of manufacturing operations, but of our research policies and programmes. For where castings are concerned, tests of quality, properly designed, conducted and interpreted, form the elements of our metallurgical vocabulary. This Paper will deal mainly with the mechanical tests usually specified by the engineering buyer, and with the translation, as far as at present practicable, from one form of mechanical test to another; at a time when industry is witnessing a veritable renascence of cast iron as a metallurgical material, such correlation is calculated to reduce the time and expense involved in testing and to promote proper standardisation of testing procedures. It should also help to convince the engineering designer of the great economies that can be effected by the rational design of castings and by full co-operation between designer, foundry engineer and metallurgist. For the need for a high factor of safety in cast-iron design arises not only from unexpected stresses and possible lack of homogeneity, but from uncertainty arising from lack of relationship between test-bar and casting. The consequences of mistesting are always against the founder.

Criteria of Quality of Cast Iron.

What is the most satisfactory criterion of the quality of that wide series of heterogeneous crystalline aggregates which we call cast iron? The founder, the chemist, the physicist, the metallurgist and the engineer do not at present agree on what property or quality of cast iron best forms a basis for its consideration. The chemist favours analysis, the ultimate composition of the metal being incontrovertible; and indeed it gives valuable information which can be obtained in no other way. But commercial analysis does not usually include elements other than C, Si, Mn, P, S, the so-called rare elements, gases, etc., being omitted. Thus a tendency arises to ascribe anomalies of behaviour to these undetermined elements, or, more commonly, to criticise the chemist's work, quite undeservedly, because conventional analysis does not, and indeed cannot, explain these anomalies. Chemical analysis, moreover, does not indicate the manner in which the elements of composition are combined.

The physicist can associate changes of quality with changes in density, in thermal, electrical or magnetic properties, but the correlations are not yet sufficiently well known to enable these properties to be used in specifications.

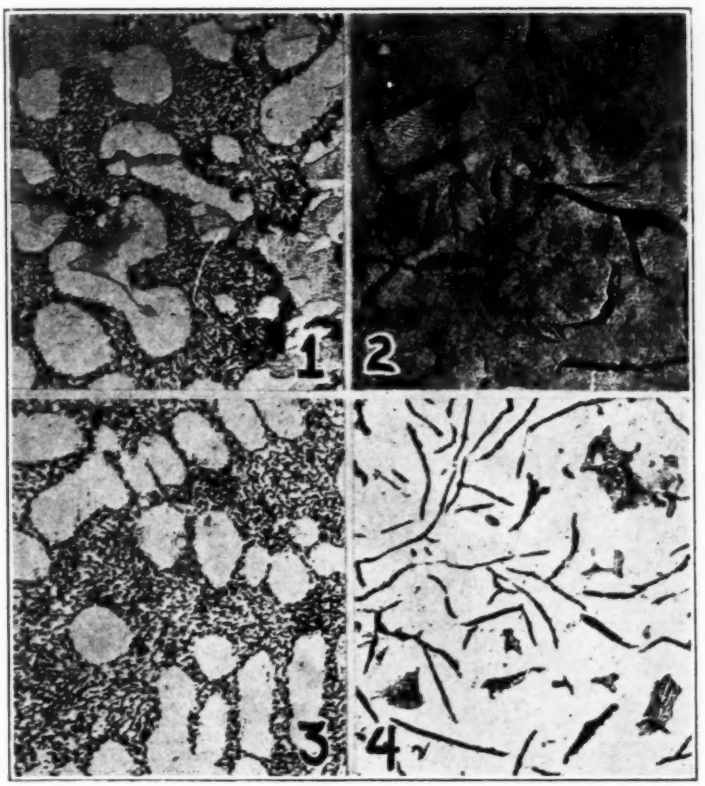


FIG. 1.—GREY CAST IRON. MEDIUM SILICON. × 200. (COMPOSITION SIMILAR TO THAT OF FIG. 2.)

FIG. 2.—GREY CAST IRON. MEDIUM SILICON. × 200.

FIG. 3.—GREY CAST IRON. HIGH SILICON. × 200. (COMPOSITION SIMILAR TO THAT OF FIG. 4.)

FIG. 4.—GREY CAST IRON. HIGH SILICON. × 200.

Importance of Micro-Examination.

The metallurgist, of course, knows that the strength properties so important to the engineer are determined primarily by structure, which is not wholly determined by composition, or even by composition and rate of cooling, as will subsequently be shown, but which is the resultant of all the forces at work. He therefore leans towards microscopic examination, and the microscope indeed gives important information, not only about general structure, but about its variation from point to point in the section. It shows the distribution of compounds as they exist, but apart from the inability of the microscope to show directly the elements in solution, silicon, manganese, aluminium, nickel, chromium, it is impracticable as a routine acceptance test, because any given examination is highly localised and the technique of polishing and etching is not sufficiently generally known.

The founder naturally looks to some form of fracture test, preferably of a type which will yield a result before the casting is actually made, such as a chill test. The hitherto unresolved connection between composition and structure to be referred to below suggests that analysis should always be accompanied by some form of fracture test, microscopic or macroscopic. The fracture test is sound for the same reason that the micro-examination is sound, but is, of course, far less sensitive. It is logical, because metal for many castings which it would be impossible to judge by a purely mechanical test (such as for chilled rolls) can be satisfactorily judged by a combined fracture and chill test. Keep's test, in fact, which incorporates a chill test, is still used in some British foundries. So much depends, however, on the size of the casting, its purpose and composition, that a standard chill test is impracticable, and there is as yet no agreement on suitable form, quite apart from size. Most foundries using the test work out a chill test empirically to suit their range of work. This duly integrates all the factors at work, and it is in this sum that the foundryman is really interested.

Variation in Behaviour of Cast Iron.

The practical founder is, of course, aware of unexpected and unpredictable variations in the behaviour of cast irons of the same composition, and this has recently been confirmed in an interesting manner in some work done by the British Cast Iron Research Association.[1] *

Figs. 1 to 4 show synthetic cast irons, crucible-melted, each at the same magnification. Fig. 2 shows the normal structure of pearlite and graphite found in ordinary engineering irons. Fig. 1 shows a structure consisting of fine or supercooled graphite and ferrite of a kind which has occasionally been produced by superheating cast iron. The structure in Fig. 1 did not obtain over the whole of the bar, but existed in substantial quantities in the normal pearlite-graphite structure.

These two irons were virtually of the same composition (see Table I) and cast in bars of the same size. The factors of composition and rate of cooling were therefore constant. The differences in structure are due to differences, accidental or designed, in melting conditions, which have been demonstrated to have profound influences on the product and which formally introduce a third great influence on properties, unforeseen changes in which are capable of explaining many of the anomalies of behaviour from which cast iron suffers. The present purpose is served by demonstrating these differences

* Exchange Paper of the Institute of British Foundrymen presented to the American Foundrymen's Association at the recent Cleveland Convention.

* See Bibliography for Reference Numbers.

without discussing the reasons for them. It suffices to say that Dr. Norbury has evolved a theory to explain why graphite flakes below a certain critical size become associated with ferrite rather than with pearlite, and above this size pearlite may be associated with every size of graphite up to the coarsest obtainable from a given size of section and composition. Most of the observations made on these irons can be tentatively explained by assuming that the irons crystallising in the ferrite—fine-graphite system are initially free from graphite nuclei, and that irons crystallising in the pearlite—normal-graphite system are not free. In the former case the melt is supercooled and the graphite appears spontaneously throughout the mass in the "labile shower" of the crystallographers, while in the latter case the flakes build up on the existing and never completely dissolved nuclei, flakes also joining others to form longer flakes. It has been possible to melt a pig-iron and compel it to solidify in either system at will, according to whether nuclei were present or absent.[2] Figs. 3 and 4 similarly represent two structures from irons of similar composition, but higher in silicon than Figs. 1 and 2; Fig. 4 shows the usual ferrite—normal-graphite, and Fig. 3 ferrite—fine-graphite as shown in Fig. 1. In this case the structure Fig. 3 occupied the whole area of the bar.

Table I.—*Chemical Analyses.*

Reference.	T.C.	C.C. on 1.2-in. bar.	Gr on 1.2-in. bar.	Si.	Mn.	S.	P.
Fig. 1.. ..	2.91	0.62	2.29	1.82	0.67	0.03	0.03
Fig. 2.. ..	2.94	0.80	2.14	1.70	1.00	0.03	0.03
Fig. 3.. ..	2.81	0.14	2.67	4.53	0.98	0.03	0.03
Fig. 4.. ..	2.71	0.17	2.54	4.46	1.10	0.03	0.30
Table II—Iron A ..	3.2	1.00	2.20	1.37	0.94	0.09	0.18
Table II—Iron B ..	3.5	1.02	2.48	0.98	1.01	0.09	0.21
Fig. 7—A, B, C ..	3.51	0.78	2.73	2.03	0.52	0.07	1.04
Fig. 8—A, B, C, D, E	3.53	1.04	2.49	1·03	0.35	0.11	0.40
Fig. 9A, B, 17 A, B, C	3.57	—	—	1.58	0.52	0.10	0.65
Fig. 10A ..	3.55	—	—	1.95	0.50	0.08	0.72
Fig. 10B ..	3.71	—	—	1.29	0.62	0.09	0.59
Fig. 10C ..	3.50	—	—	0.68	0.35	0.18	0.64
Fig. 16A ..	2.89	—	—	1.88	0.99	0.10	0.23
Fig. 16B ..	3.09	—	—	0.90	0.34	0.14	0.26
Fig. 16C ..	3.46	—	—	1.57	0.45	0.10	0.43
Fig. 16D ..	3.37	—	—	2.21	0.64	0.07	0.56

A wide variety of mechanical tests has been made on irons of similar compositions in both systems.[2] There are practical difficulties in rendering an iron completely nucleus-free, and most of the irons containing ferrite—fine-graphite are mixed structures of this with pearlite—normal-graphite (normal, that is, for the thickness of section and composition involved). Irons composed wholly of pearlite—normal-graphite have high mechanical strengths. Irons wholly of ferrite—fine-graphite appear to have strengths comparable with those of the pearlitic irons, and, it may be noted, they are metallurgically stable. An iron of mixed structure, however, is definitely weaker mechanically than an iron of either system alone. Tensile, transverse, repeated impact, Brinell and machining hardness, and shear tests, show that the mixed structures are weaker and softer than the all-pearlitic irons. The ferrite—fine-graphite iron is markedly darker to the eye and more sooty in appearance than the pearlite—normal-graphite iron, which has the usual grey steely fracture. The combined-carbon content forms an index of the extent to which the structure is mixed. An all-pearlitic iron has the usual eutectoid percentage, while in an all-ferritic iron the value is very low; sized structures show intermediate values, according to the percentage of pearlite present. These points are illustrated by Table II, which gives the mechanical properties of the irons shown in Figs. 1 to 4.

This shows the high strength of the usual pearlite—normal-graphite structure, Fig. 2, indicated by all the tests. Fig. 4, a higher silicon iron of similar graphite formation, is consistently weaker and softer, as would be expected. Fig. 3, wholly of ferrite: fine graphite, is of the same order as Fig. 2, the pearlite—normal-graphite iron, but is markedly weaker on impact.

Table II.—*Mechanical Tests on Irons Figs.* 1-4.

Fig.	Transverse lbs./sq. in. 1.2-in. bar.	Tensile tons/sq. in. 1.2-in. bar.	Brinell 1.2-in. bar.	Repeated impact 0.875-in. bar.
1	51,800	14.4	207	Mottled
2	89,100	23.4	241	3,476
3	77,500	15.1	235	235
4	56,700	12.7	178	150

Fig. 1, which should therefore be of the same order as Fig. 2, is low, because the structure is mixed. Fig. 3 has a higher Brinell hardness than Fig. 1 on account of the hardening effect of additional silicon in solution.

These broad differences are of great practical importance, because in the ordinary processes of manufacture it appears to be difficult to get an all-ferritic—fine-graphite structure, but from personal experience, examples of mixed structures are repeatedly found in commercial pig-irons and castings, and a number of cases of difficulty in practice have been found associated with this mixed structure.

Another most important difference is the fact that the ferrite—fine-graphite irons, in spite of their low combined carbon, are much more sensitive to chilling, as shown by Figs. 5 and 6. Thus, a 1.2-in. bar, with 3.0 per cent. total carbon, is just white, with 0.85 per cent. silicon, in the pearlite—normal-graphite system, while in the ferrite—fine-graphite system an iron with the same total carbon is white with no less than 1.3 per cent. silicon. Thus an iron which is liable to crystallise as ferrite—fine-graphite is much more liable to troubles associated with chilling. Cases of so-called "inverse chilling" are often nothing more than areas of white iron corresponding to the ferrite—fine-graphite system surrounded by grey areas of pearlite—normal-graphite.

How it Affects Malleable Iron.

The differences noted above between grey irons of similar composition are parallel by differences between white irons of similar composition, in which in the case corresponding to the supercooled system, the eutectic is a fine-dispersed structure, whereas in the case corresponding to the normal system the eutectic is a coarse, coalesced structure. The mechanical properties obtained from both white and malleable (white-heart) cast irons are superior in the supercooled than in the normal system. It thus appears that except in a few cases where a supercooled grey iron is wanted for special purposes, grey-iron founders should aim at producing the normal system, and white- or chilled-iron and white-heart malleable founders the supercooled system. There appears no reason why this should not equally apply to black-heart malleable cast iron.

There is thus definite scientific evidence to show that composition, even in a single size of bar, does not determine structure, so that analysis alone is not necessarily a reliable guide to mechanical properties. This confirms the principle previously adopted in great Britain of avoiding incorporation in specifications of definite limits of analysis. The mechanical results depend far more upon melting conditions; small differences in composition, in fact, are now regarded as of minor importance. Furthermore, a particular composition may restrict a maker's use of raw materials and may stifle research directed towards getting better results from compositions outside the specification. Hence the British principle is to leave the maker to obtain definitely specified mechanical test results. Incidentally these results may explain the tenacity with which British founders adhere to fracture as a guide in buying pig-irons, even when they have the analysis as well, for pig containing ferrite—fine graphite will show dark areas in patches where this structure occurs. Chilled pig also may show this structure, particularly at the edges. Even when the structure is pearlitic, results on remelting are affected by graphite size in the pig, which is capable to some extent of assessment by fracture examination.

Thus the criterion is reached that is satisfactory to the engineer, namely, mechanical tests. As the user or buyer, his wishes carry great weight and are not likely readily to be overruled. Hence, whatever use may be made of foundry or laboratory tests as auxiliaries, the main concern must be with mechanical tests. Proper correlation will do much completely to justify their use on fundamental grounds. Before considering them it is necessary to consider more fully the influences affecting mechanical properties.

Composition and Rate of Cooling.

It is generally accepted that composition and rate of cooling are determining influences on the mechanical properties of cast iron and the existing methods of control, by which silicon content is suited to a particular dominating thickness, embody the principle involved. The changes brought about by variations in phosphorus are well known, although the rôle of manganese, in relation to sulphur, has been much debated. It has recently been demonstrated[3] that manganese tends to graphitise grey iron up to a limit of about 0.3 per cent. manganese in excess of the quota required to satisfy the sulphur as manganese sulphide (MnS); after that point manganese tends to harden grey iron. The former action is indirect, due to the removal of the potent carbide-stabilising action of sulphur, and the latter is the normal carbide-stabilising action of manganese. There is evidence that this is equally true of white-heart and black-heart malleable, although the curve of change connecting combined-carbon content with manganese content is so flat that opinions may well differ as to the precise manganese value at which, other things being equal, the metal is at its softest.

Variations in rate of cooling are affected by considerations other than the mass and disposition of metal in the casting, its specific heat and thermal conductivity. The rate is affected by the pouring temperature, mould temperature and the mass, specific heat and thermal conductivity of the mould material. In a given case factors other than thickness can usually be kept reasonably constant. The influence of

variations in rate of cooling can, therefore, be studied by testing bars melted under the same conditions and of the same composition, but cast in a range of sizes.

Melting Conditions.

Variations in melting conditions influence the properties of the metal so markedly that they transcend such minor differences in composition as inevitably occur in ordinary practice, in spite of efforts to secure uniformity. These variations, not readily recognisable in practice, and as yet seldom recognised, are responsible for many anomalies met in foundry practice. In a given foundry they may be due to atmospheric variations, changes in coke supplier or variations in supply, changes in raw-material supply, such as pig-iron and scrap, changes in melting practice, such as the use or disuse of ferro-alloys, or variations in richness or leanness of ferro-alloys, even if amounts used are adjusted to get the same composition (for ferro-alloys differ markedly in their carbon content and capacity for throwing carbon out of solution), variations in pouring temperature and general furnace practice, and so on. Between foundries there may be differences due to methods of charging, furnace design, raw materials, fuel, fluxes, the method of make-up of charge, use of ladle additions, etc., even when they aim at the same ultimate composition and mechanical properties. Internationally, there are important differences in fuels and ferrous raw materials, the effects of which are not often appreciated. The magnitude of the effects of these conditions and their wide variety are quite sufficient to justify the belief that every foundry and even every casting forms a case to be studied by itself. They give the metallurgy of cast iron and the practice of founding the charm of variety. If the nucleus theory is correct, they operate by influencing the size and distribution of graphite, and in cases where the graphite size falls below a critical minimum, by producing a complete change in structure.

As the effect of each variable becomes understood, foundries will more and more approximate to the optimum condition of working and their test results will increasingly converge to the same point; then, and only then, will the production of cast iron be completely controllable from the scientific point of view.

TABLE III.—*Mechanical Properties.*

Dia. of bar.	Transverse test. Rupture. Lbs./sq. in.		Transverse test. Deflection. Inches on 18-in. centres.		Tensile test. Lbs./sq. in.	
	A.	B.	A.	B.	A.	B.
Inches.						
1.2	72,500	70,000	0.24	0.24	45,000	40,300
2.2	64,250	59,800	0.19	0.22	35,800	33,400

As an illustration of the effect of varying one of the normally-operating group of melting conditions on irons of the same composition, two mixtures, calculated to give the same composition in the casting, were cast from the same cupola in bars 1.2 in. and 2.2 in. dia. The first charge was made up of equal proportions of steel and white iron, with enough 12 per cent. ferro-silicon and ferro-manganese to yield a strong grey iron. The second charge was made up of the same materials, except that 40 per cent. ferro-silicon was used instead of the 12 per cent., the proportion, of course, being lowered to give the same silicon content in the melt. Unfortunately, the silicon contents differed somewhat in the two melts, but the illustration is strengthened thereby, because the higher silicon iron is the stronger mechanically. The analyses are given in Table I and the mechanical properties in Table III.

A simple change in raw-material supply has, therefore, produced a change in test results that is consistent and by no means insignificant. Micro-examination revealed, in addition to the slightly larger amount of graphite in B, a coarser graphite structure, although both were pearlitic. The influence of melting conditions can, therefore, be studied by testing bars of the same composition and of the same size, or range of sizes, melted with appropriate variations (preferably, of course, one at a time) in the conditions of melting.

Two conditions generally regarded as affecting composition are most conveniently treated as concerning melting conditions. One is the effect of graphite content. It is, in a measure, a function of melting conditions, because, whatever the original total carbon content in an iron, the melting conditions will determine whether there is a carbon pick-up or a carbon loss, and how far this changes with remelting. Mackenzie has shown[4] that, irrespective of the total carbon content of the original charges, a given melting furnace tends to produce, and on sufficiently repeated melting will produce, a total carbon content peculiar to the furnace. Furthermore, the form (distribution) of the graphite has an important influence on the structure, and this, as shown above, is determined, not by initial composition, but by melting conditions, largely the melting temperature and the time the metal is held at that temperature. For the same reason the use of steel or low-carbon scrap as a constituent of the melt (as an alternative to another mixture) must be regarded as altering the conditions of melting rather than composition.

T.C. + Si Unreliable as Basis.

In view of the attempts frequently made to associate the properties of cast iron with the sum of total carbon and silicon or some fraction of the silicon content, it should be noted that correlations are only likely to be established for one set of melting conditions (and even then unintentional changes may have occurred). Any attempt to do so for irons produced under various conditions usually fails, because it is impossible for any such formula to take into account the form as well as the quantity of graphite present. The author has found such correlations when, and only when, melting conditions are maintained constant.[6] It seems probable that when a set of melting conditions remains constant, the form of graphite distribution remains approximately the same.

Similarly, many attempts have been made to establish correlations between different types of mechanical tests, whether such tests measure the same basic property or not. Individual investigators have no difficulty in establishing pairs of correlations for irons made from the crucible or from the same cupola, but they do not hold universally for all conditions of melting, and there is no difficulty in showing this.[5] Table III shows at once the number and the range of correlations established by individual investigators, and if the equations for any pair of tests are plotted the variations are striking. Indeed, they indicate the range of variation to be expected from differing melting conditions.

Such correlations are only valid for one prescribed set of melting conditions. They may, however, be profitably established by each foundry for its own purposes; periodical checks then become an excellent test of progress and of any improvement in conditions of melting.

TABLE IV.—*Relations between Mechanical Tests.*

T = Tensile (tons/sq. in.).
R = Transverse (tons/sq. in.).
C = Compression (tons/sq. in.).
S = Shear (tons/sq. in.).
B = Brinell (3,000/10/30).

Tensile and Shear.

$T = 0.92S - 1.2$	(Audo)
$T = 0.9S - 1$	(Le Thomas)
$T = 0.75S$	(Est Rly.)
$T = 0.63S$	(Planas)
$T = 0.54S$	(Herman)
$T = 0.59S$	(Si. > 1.6, Pisek)
$T = 0.92S - 6.8$	(Si. < 1.6, Pisek)
$T = 0.854S$	(Rudeloff)

Tensile and Brinell.

$T = 0.13B - 8.25$	(Portevin)
$T = 0.11B - 4.23$	(Schüz)
$T = 0.17B - 17$	(Rudeloff I)
$T = 0.2B - 20.5$	(Rudeloff II)
$T = 0.17B - 20.7$	(Pisek)
$T = 0.045B + 3.2$	(Herman)

Compression and Brinell.

$C = 0.38B - 34.3$	(Le Thomas)
$C = 0.32B - 3.2$	(Portevin)

Tensile and Transverse.

$T = 0.5R$	(Jungst)
$T = 0.5R$ to $0.55R$	(B.C.I.R.A.)
$T = 0.475R$	(Rudeloff)
$T = 0.43R$	(Pisek)
$T = 0.49R$	(Bach)

Compression and Tensile.

$C = 2.5T + 18$	(Portevin)
$C = 4T$	(B.C.I.R.A.)

Compression and Shear.

$C = 3S + 3$	(Le Thomas)
$C = 2.85S$	(Herman).

Shear and Brinell.

$S = 0.13B - 12$	(Le Thomas)
$S = 0.08B$	(Ferrer)
$S = 0.29B - 35.6$	(Pisek)
$S = 0.15B - 15$	(Audo)

Test Procedure.

The simple procedures underlying investigations on cast-iron tests can be formulated as follow: (1) The effect of variations in composition on the properties of cast iron may be studied by testing bars of the same size, cast under the same melting conditions, but with appropriate variations of composition; (2) the effect of variations in rate of cooling on the properties of cast iron may be studied by testing bars of different sizes made under the same melting conditions, and (3) the effect of variations in melting conditions—individual or aggregate—on the properties of cast iron may be studied by testing bars of the same size and composition under varying melting conditions.

Mechanical Tests.

The decided preference of the engineer or inspector for mechanical tests must not blind us to the fact that they are susceptible of very great improvement in themselves and of a marked degree of correlation among themselves. Too often the preference of the engineer has been dictated by forms of test-piece and testing procedures found suitable for steel and other ductile materials. Bars specified by engineers frequently ignore the connection between properties and rate of cooling, as in calling for a large casting to be represented by a small bar and *vice versa*; this arises mainly when castings are covered by a bar taken from a specification not necessarily relating to the same general type and size. Further complication is introduced at times by the use of a bar cast as an integral part of the casting (" cast-on "), although there

may be no relation between the thicknesses concerned, or no instruction as to the place of casting-on, the length of the connectors or disposition of the bar in relation to the cooling mass of the casting. Circumstances making it impossible for him to do both, the founder is at present often forced to decide whether to make a good test-bar or a good casting, or an unsatisfactory compromise.

Effect of Removal of Skin.

The skin effect is an important consideration in mechanical tests. In some tests, such as transverse, the bar can be tested as cast or it can be machined prior to testing. In a grey bar the metal is more open and weak at the centre than immediately under the skin. The progressive removal of stock will, therefore, result in a progressive weakening of the bar. This effect will be considered later, but it is common experience, which the author has repeatedly confirmed by direct experiment, that skin machining yields a stronger bar; it may increase the transverse strength 10 per cent. Early American tests showed that the removal of 0.25 in. of stock diminished the strength, but if, say, 0.06 in. is removed on a small bar, or 0.1 in. on a large bar, the strength is markedly increased, as is the deflection. This is probably due to the fact that the skin of a green-sand bar contains minute superficial fissures, which may cause premature rupture under test, and, possibly, a release of skin stress, of which the fissures may be regarded as evidence. Bars tested in transverse as cast are erratic in their results, while skin-machined bars are more uniform and regular. Thus it is to the interest of the manufacturer to skin machine transverse bars, although this procedure is less necessary for dry-sand or oil-sand than for green-sand bars.

Effect of Thickness.

For a given mixture and assuming a grey structure throughout, a thick bar will, per unit of area, be weaker than a thin bar. By casting a series of bars of varying diameters from the same ladle (*i.e.*, same composition and melting conditions), the author has shown that the change in strength with size is continuous, whatever type of test be adopted.[6 7 8]

For some tests, tensile and transverse for example, it is easy to test the bar at or near the cast size. The alteration in mass effect, due to skin machining, can be disregarded, as the effect on the section is slight. For other tests, however, shear, compression, impact, fatigue, it is impracticable to test many sizes, as this would involve a battery of machines or very large machines. Generally, the number of sizes that can be tested is limited to one, and this is usually small. Comparisons are often made between one type of test on bars at or near the cast size, and another type of test on small diameters machined from them, as if it were taken for granted that the metal behaves in the small size exactly as it does in the large size. The soundness of this assumption—for it is an assumption—requires to be examined in any consideration of correlation of available tests. Illustrations of effects of skin machining and of thickness may most conveniently be considered as arising from the tests concerned.

Transverse Strength.

This test remains the simplest, cheapest and most generally used test for cast iron, and the breaking load and deflection figures are universally understood. Its usual mode of interpretation often yields results, however, which are contrary to the facts, and precludes comparison between transverse and other specific stresses, such as tensile and compression and between transverse results on bars of other shapes and sizes of the same material.

The author recommends as a method of expressing transverse results, the conversion of breaking load into a transverse rupture stress per sq. in. of the cross section at fracture. The transverse test as ordinarily conducted forms a case of a weightless, end-supported, centrally-loaded beam. For supports L inches apart a central load of W lbs. gives a bending moment at the centre of $\frac{WL}{4}$. The resistance offered by the beam depends on its size and shape and may be expressed as fZ, where f is the specific resisting stress set up in the beam and Z is a constant, the section modulus, for a given section, taking into account the size and shape of the section. Within the elastic limit $fZ = \frac{WL}{4}$. When the elastic limit is passed the formula ceases to be strictly true, but it is convenient to measure the stress f at fracture by means of the value $\frac{WL}{4Z}$. For a standard bar $\frac{L}{4Z}$ is obviously constant, so that f = KW. A straight line conversion is therefore possible from W to f, and can be used for bars accurately machined to a given size before testing. In practice, however, most bars are tested as cast, and it is practically impossible to cast a bar accurately to specified size. Where differences between cast and specified sizes are not ignored the practice has grown up of converting by proportion the result obtained on the cast size to that which would be obtained on the specified size. The author has shown[6] that this procedure is fallacious, since it assumes that the transverse rupture stress is the same for both sizes. This is not the case, for the larger of the two sizes will have the lower breaking stress, and the greater the difference the more pronounced will be the error. While the error is small in converting to a nominal specified size from a closely approximating cast size, the conversion from small to large bars and *vice versa* gives completely erroneous results.

By substituting appropriate values for Z in the formula, the transverse rupture stress can be expressed in terms of bar dimensions. For the round bar generally used in U.S.A. and now adopted as the British standard, $Z = 0.0982d^3$, where d is the bar diameter. Hence $f = \frac{WL}{0.39d^3}$. For a bar tested at 18-in. centres, f in lbs. per sq. in. becomes $\frac{0.0205W}{d^3}$, for W in lbs. The precise nature of change of strength with section, obscured by the use of breaking loads, can be readily demonstrated by the use of transverse rupture stress.

(To be continued.)

Scottish Founders' Outing.

The annual excursion of the Scottish Branch, Institute of British Foundrymen, took place on Saturday, May 31, when a party of members and their ladies left Glasgow for Princes Pier, Greenock, where they boarded the L.M.S. steamer "Jupiter" for a sail to Rothesay and through the Kyles of Bute to Kames and Ormidale, returning to Gourock to entrain for the return to Glasgow. The weather, although dull and rainy during the early part of the day, cleared up later, and the party spent a very enjoyable time. Tea was served on board, at which the President, Mr. H. Winterton, presided, and in the course of a short speech welcomed the members and friends and expressed the hope that everyone would spend an enjoyable time. In the name of the Branch Council he thanked all the members who had supported the function; it was his last appearance before them as their President, and he hoped that when the time came for a similar function next year, that they would accord the same support to Mr. Miller, the President-elect, as had been accorded him.

Catalogue Received.

Refractories. — Messrs. Gibbons (Dudley), Limited, of Dibdale Works, Dudley, Staffs, have sent us an advance copy of their latest catalogue, which is an extremely handsome publication. The coloured illustrations of the bricks are distinctly novel, whilst the detailing of the standard shapes and sizes, utilitarian. On page 3 a questionnaire is set out for the use of customers; whilst this is totally unnecessary so far as foundries are concerned, the manufacturers cannot be expected to have profound knowledge of every type of furnace used in industry. Each new furnace development, such as the rotary pulverised fuel-fired furnace, demands individual attention, and herein is the utility of the questionnaire. On this and subsequent pages illustrations have been inserted, but as they carry no or insufficient captions they are more decorative than useful. Page 5 illustrates the chief types of bricks and retort shapes made, with reference to pages containing detailed information. From this page onwards, we rather feel that too much bias is evidenced towards the maker's viewpoint rather than the consumers. For instance, on page 6, dealing with the 95 per cent. silica bricks, a general appeal is made to the coke-making, glass-melting, steel-refining industries. Now each of these important activities is worthy of a direct attack. *En résumé*, we imagine that it would be better publicity to issue catalogues exactly of the design and make up of the one under review, embodying, as it does, the loose-leaf principle, and after a general section, which would stress the facilities for service germane to the Gibbons' organisation, would devote the balance to each of the chief refractory-using industries—iron and steel works, foundries, glass works, gas and coke works and so forth. Pages 7 and 8, for instance, deal with vertical retorts and coke ovens, and as such would be peculiar to a catalogue issue to that industry. However, this personal outlook is perhaps due to a selfish desire to see manufacturers give to the foundries catalogues undiluted with appeals to other and sometimes competitive industries.

A useful diagram appears on page 17. It details the standard sizes of bricks. We imagine that difficulty has been encountered in choosing names for some of the shapes, as there is a complete lack of uniformity in the nomenclature of furnace bricks, and there is a need for standardisation—at least so far as the printed language is concerned. The choice used in this catalogue is commendable. Finally, this brochure ranks amongst the best that has passed through our hands in recent times.

Publication Received.

The Poumay Cupola.—The Constructional Engineering Company, Limited, of Titan Works, Birmingham, the manufacturers of the Poumay cupola, have reprinted Mr. John Cameron's Paper dealing with this system, which was printed in a recent issue. In addition to the Paper several testimonials are included. We suggest that now this lecture is available in brochure form that executive offices would be wise to secure copies for their staff, as its assimilation will induce a proper perspective of the potentialities of intelligent furnace control.

Merchandise Marks Act, 1926.

The Board of Trade announce that a draft Order in Council was laid before Parliament on May 28 in pursuance of Section 7 (1) of the Merchandise Marks Act, 1926, requiring an indication of origin to be shown on the following classes and descriptions of imported goods: Bolts, nuts, rivets, set screws, coach screws and studs. Communications on the subject may be addressed to the Assistant Secretary, General Department, Board of Trade, Great George Street, S.W.1.

Graphite in Cast Iron.

By Archibald Allison.

It is generally agreed that the physical properties of cast iron are largely governed by the quantity and form of the graphite it contains, but controversy continues as to the production of the different forms. Examination of the fracture with the naked eye affords some indication of the quality of the metal, and the microscope reveals three formations of graphite, flakes slightly curved, small curly flakes arranged in floral patterns, and nodules or spots. Even the large, coarse flakes radiate from centres, and the curly graphite, whilst apparently starting from centres, puts out branches which have smaller spirals or flowers. The microscope only sees a plane section cut at random, and hence the solid geometry must be deduced. The microscopist frequently searches for and only finds in an odd corner of his section a characteristic field to photograph.

FIG. 1.—INNER EDGE OF MILD-STEEL PIECE. × 100.

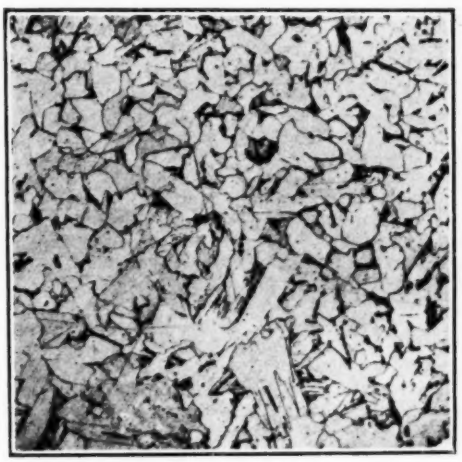


FIG. 2.—OUTER PORTION OF MILD-STEEL PIECE. × 100.

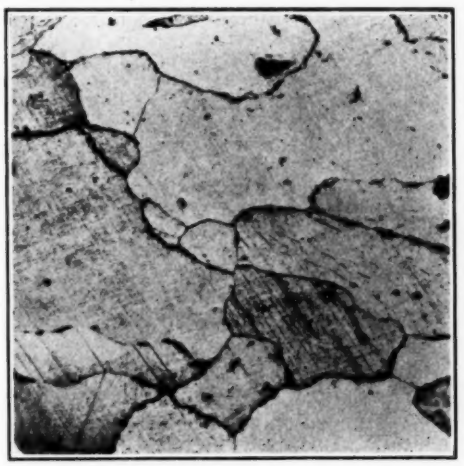


FIG. 3.—STALLOY BEFORE TREATMENT. × 100.

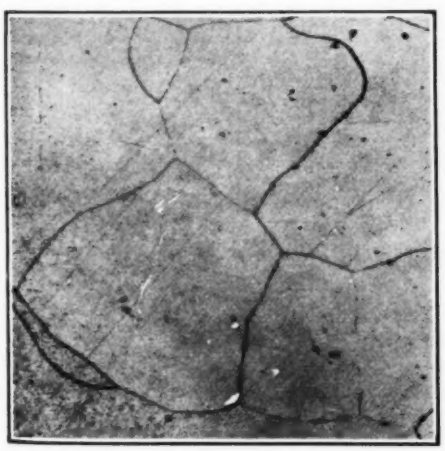


FIG. 4.—STALLOY AFTER TREATMENT. × 100.

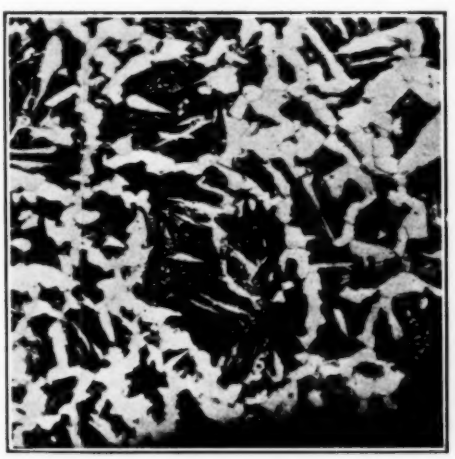


FIG. 5.—INSIDE EDGE OF THE STEEL BAR. × 100.

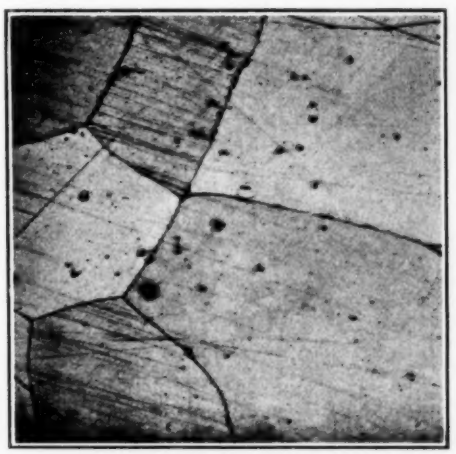


FIG. 6.—INSIDE EDGE OF STALLOY PIECE. × 100.

The Nuclei Theory.

In connection with the desirable curly and nodular forms, a theory has been developed that in melting pig-iron in the cupola, the coarse graphite produced in the pig-iron by smelting at high temperatures does not completely dissolve, but remains as an emulsion in the molten metal, and ultimately in the solidification of the castings forms nuclei for the formation of coarse graphite flakes. In other words, the cast iron will retain, by a law of heredity, the habit of the original pig-iron. This view is based upon the presence of kish or free graphite on tapping pig-iron from the blast furnace, and also in cavities in the pigs themselves. The physical explanation of kish is not at all difficult. If the iron in dropping down the blast furnace is very hot, it will naturally take into solution the maximum amount of carbon proportional to its temperature.

On collecting in the well at the bottom of the furnace its temperature is continually falling, and the metal being unable to hold in solution the same amount of carbon ejects the excess as kish. With frequent tappings the iron flows into the pigs while the precipitation of graphite is proceeding, so that the presence of kish on the surface and in the cavities is quite natural. Whether the graphite is trapped in the act of separation as the metal rapidly cools in the pig, or is precipitated from the solid metal, is a point to be considered. Normal cast iron on freezing, immediately after changing from liquid to solid is white iron, and the carbon is ejected from solid solution according to conditions of composition and speed of cooling.

A Pointer from the Thickness of Graphite Flakes.

The graphite present in pig-iron of very open fracture appears, under microscopic examination, as coarse flakes in a matrix of ferrite. At a magnification of 100 dia. the coarsest flakes rarely appear to be thicker than $\frac{1}{32}$ in. Even if it be granted that the flakes appeared to be $\frac{1}{16}$ in. thick, this would give an actual thickness of 1/1,600 in. to the coarsest flakes. It is difficult to conceive that although in melting pig-iron in the cupola the metal is raised from the cold, solid to the hot, liquid condition in twenty-five minutes, that carbon flakes so minutely thin as 1/1,000 in. should not be completely dissolved, being associated, as they are, most intimately with the metal.

Experimental Evidence.

To obtain some evidence of the solubility of graphite, experiments were conducted to determine the carburising effect at high temperatures of graphite upon such materials as were available. Graphite was prepared from pig-iron by mixing old packets of drillings from the laboratory, comprising several different kinds of iron at random, and including both high- and low-carbon irons. A quantity of the sample was digested with dilute nitric acid and thoroughly boiled. The residue was filtered and washed by decantation and finally dried. The sample of

graphite thus prepared actually contained 44 per cent. silica, but one experiment was performed with this impure material, though afterwards treatment with hydrofluoric acid was employed to purify it.

Test pieces were prepared about 3 in. long and ½ in. dia. A hole was drilled ⅞ in. dia. and 2 in. deep in each piece, and fitted with a screw to make a closed cavity. The material used was "stalloy," containing C 0.05, Si 4.53 and Mn 0.05 per cent., and mild steel with C 0.15 and Mn 0.45 per cent. The cavity of a test piece of each material was closely packed with the

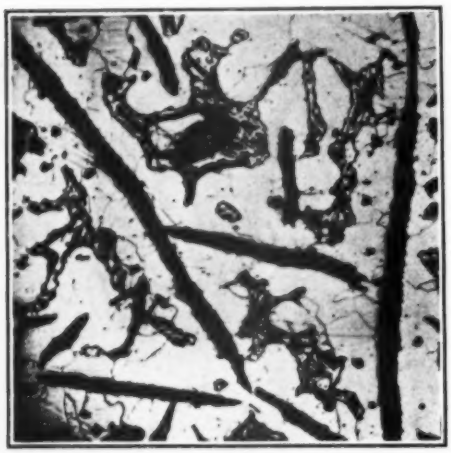


Fig. 7.—Pig-iron before Heating. × 100.

graphite and the screw inserted. The two test pieces were placed end to end in the ordinary laboratory combustion furnace, and the temperature controlled by a Pt—Pt-Rh thermocouple pyrometer. The pieces were kept at 1,050 deg. C. for six hours and then withdrawn from the furnace. Sections were prepared for the microscope by sawing across the middle of the cavity, so that a transverse section of ring shape was obtained.

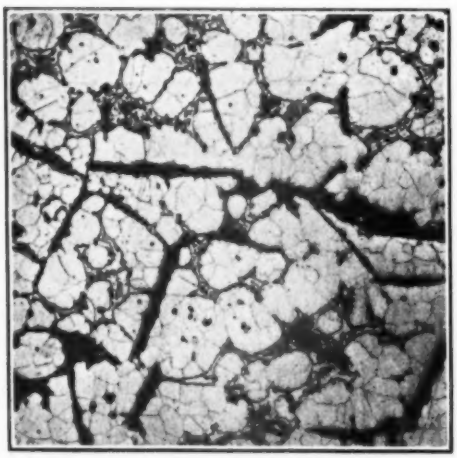


Fig. 8.—Pig-iron after Heating. × 100.

The micrographs, Figs. 1 and 2, represent the inner edge and the outer portion of the mild-steel piece. Carburisation has extended about ⅛ in. or half the thickness of the wall of the cavity. Apart from the main question, although both fields exhibit an overheated structure, the difference due to carburisation is very interesting. Figs. 3 and 4 represent the stalloy before and after treatment. The piece was cut longitudinally from a hot-rolled slab, so that the micro-section is transversely to the direction of rolling. In the treated piece the grains have developed somewhat, but no sign of carburisation is perceptible.

A second experiment was made with the purified graphite (actually 98.4 per cent. C), the pieces being kept at 1,200 deg. C. for three hours. Figs. 5 and 6 show the inside edge of the steel bar and stalloy piece respectively. Carburisation again has proceeded to ⅛ in. in the steel, but there is no sign of it whatever in the stalloy, the grains of which, however, have grown largely. Under these conditions, therefore, ferrite containing 4.5 per cent. Si is immune from carburisation. There is no difficulty in melting stalloy in the cupola, but there is no reason to think that it melts without carburisation. Typical analyses such as the following, selected from pig-iron records at random, indicate that the molten iron containing *circa* 4 per cent. Si can, and does, dissolve carbon up to 3.5 per cent.

C.	Si.	Mn.	P.
3.44	3.54	1.20	1.52
3.00	3.92	1.13	1.49
3.26	4.03	1.00	1.56
3.71	3.21	1.70	0.06
3.69	3.65	1.67	0.06

To bring the matter nearer to practical conditions, a piece of foundry pig-iron containing Si 3.92, Mn 1.2 and P 1.45 per cent. was heated to 1,050 deg. for two hours. The photomicrographs, Figs. 7 and 8, show the iron before and after. The normal pig-iron naturally contains very coarse graphite in a matrix of silico-ferrite, and very little pearlite which is associated with the phosphide eutectic. The heat treatment has only had the result of distributing the phosphide eutectic more evenly in smaller areas, and almost completely breaking down the little pearlite there was originally.

This evidence is, therefore, negative. Stalloy is as easily melted in the cupola as mild steel, although it is improbable* that the temperature is as high as the melting point of either, and hence it is a reasonable deduction that carburisation is essential to melting. In the case of siliceous pig-iron, although the melting is very rapid in point of time, the evidence that the graphite is incompletely dissolved is purely hypothetical, based on fractures and graphite form in the castings.

A New Theory.

What other hypothesis can be put forward then to account for observed phenomena? Every microscopist in studying graphite formation in cast iron must have noticed the frequency with which the flakes are entangled with manganese sulphide crystals. Repeated observations on a very rapidly cooled metal, viz., the chilled portion of chilled iron rolls, invariably reveal crystals of sulphide differing in size very little from those of the interior or grey portion of the metal. The micrograph, Fig. 9, exhibits these crystals in the barrel of a chilled roll.

This would indicate that the crystals are already solid in the liquid iron before casting, in the form of an emulsion. Since sulphur enters the iron chemically from the coke, etc., the manganese sulphide appears to separate out at some temperature over 1,300 deg. C.; in other words, it is insoluble in iron below 1,300 deg. C.

It is now suggested that the precipitation of graphite is produced by the sulphide crystals acting as nuclei, like any other nuclei in supercooled solutions, or like grains of sand in boiling liquids assist ebullition. Of all irons, Swedish pig-iron is probably lowest in sulphur, and hence the number of sulphide crystals is small and widely scattered, and hence the frequency of small and curly graphite in this iron, indicating supercooling for lack of precipitants.

* We cannot endorse this statement. If a crucible containing mild steel were embedded in coke just above the tuyeres and the normal blast utilised, we feel convinced the contents would melt as easily as in pit-fire practice.—Editor.

Evidence from Malleable.

The further micrograph, Fig. 10, appears to supply additional evidence of the precipitation from centres. This represents nodules of graphite in a malleable casting magnified 300 dia. It will be seen that there is a radial structure in the nodule itself indicating that in the annealing process dissociation of carbide, and precipitation of graphite has originated in a centre and proceeded outwards. It remains, therefore, to suggest a theory to account for the well-known difference of structure of the

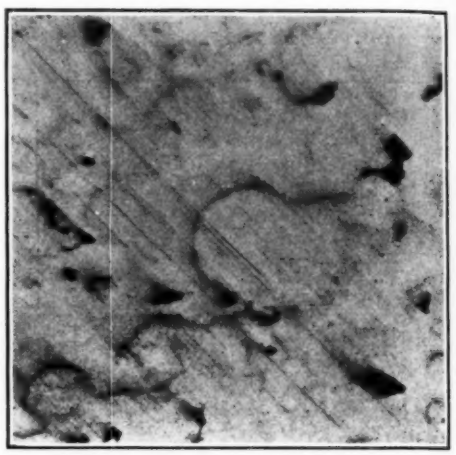


Fig. 9.—Crystals of Manganese Sulphide in Barrel of a Chilled Roll. × 200.

graphite in superheated iron, demonstrated by the researches of Piwowarsky, Dr. Norbury and others.

Granted that the precipitation of graphite like other crystalline formations requires nuclei for propagation, it is now proposed that the complete solution of the manganese sulphide crystals occurs probably at about 1,400 deg.

Fig. 10.—Nodules of Graphite in a Malleable Casting. × 300.

C., according to the composition of the metal, and hence superheating produces a perfect solution from which the comparatively rapid cooling of reasonable volumes produces fine crystalline precipitation analogous to that from all solutions. In commercial practice, or even on a laboratory scale, the experimental verification would be impossible. The method of the Alloys Research Committee, however, working with absolutely pure materials free from sulphur, would prove very interesting.

The Institute of British Foundrymen.

ANNUAL GENERAL MEETING OF THE LONDON BRANCH.

The annual general meeting of the London Branch was held at 49, Wellington Street, Strand, W.C.2 (by kind permission of the directors of THE FOUNDRY TRADE JOURNAL), on May 15, 1930, the retiring Branch-President (MR. J. W. GARDOM) in the chair. The minutes of the preceding annual general meeting were read, confirmed, and signed.

The CHAIRMAN announced with regret that Mr. A. F. Gibbs was suffering from a nervous breakdown and was unable to be present at the meeting. This was particularly unfortunate because the Council had recommended the election of Mr. Gibbs as Branch-President for the ensuing year, and it was hoped that his induction into the chair would have taken place at this meeting.

The Chairman also took the opportunity to express to all members of the Branch his very sincere thanks for the help and support they had given him during his year of office as President. Due mostly to the efforts of the Council and the Hon. Secretary, the Branch had made progress, and all its meetings had been well attended, the attendances on a number of occasions having been quite as good as at any time previously. During the year the members of the Branch had had some very interesting visits to works, including Continental works.

Annual Report.

The BRANCH HON. SECRETARY (Mr. H. G. Sommerfield) then presented his annual report, of which the following is an abstract:—

This is the seventh annual report on the work of the London Branch of the Institute that I have had the honour of presenting, and I am satisfied that the Branch still continues its even progress. The membership to-day shows an increase over last year of 18, and this figure has taken into account all deletions and transfers as well as additions to the Branch register. Membership is divided as follows:—Subscribing firms, 3; members, 156; associate members, 92; associates, 14.

During the past seven years that I have held office I find from the Branch records that the membership has more than doubled itself, and for the future there is no need for anything but optimism. The total membership stands to-day at 265.

Since the last annual report I regret to record the deaths of the following members:—Mr. H. Cole Estep; Mr. H. Lum, and Mr. C. F. Walker. The passing of Mr. Estep and Mr. Walker were both most tragic. They were highly esteemed members of the Institute.

The past year has seen another International Congress of the Institute, organised in London to the credit of the Branch and the full satisfaction of every member of the Institute. The London Branch was honoured in the election of Mr. Wesley Lambert as President of the Institute, and the interest shown in all the functions of the Congress gratifyingly reflected appreciation for the arrangements made by the Branch for the entertainment of members and visitors from overseas. The London Branch was the first to welcome the American delegates to the Congress, and the banquet given in this connection by Sir Hugo Hirst at the Holborn Restaurant was eloquent testimony to the life and work of the Branch.

At the monthly meetings during the year a variety of subjects have been presented and discussed, the good attendances speaking well for the interest created by the Papers presented. The joint meeting with the London section of the Institute of Metals was as usual very popular. Visits have been paid to the following works:—Kryn & Lahy (1928), Limited, Letchworth; Morris Motors, Limited, Coventry, and the Gramophone Company, Limited, Hayes.

In March a party of over thirty accepted invitations from works in France, and a very interesting and instructive trip was organised. The thanks of the members are due to Mr. Beech and Mr. Ronceray for the valuable assistance they so kindly gave to ensure complete success. The above visits to works are, of course, in addition to those which were included in the Conference programme last June.

One meeting of outstanding interest was the visit of Dr. Werner from Düsseldorf. An informal dinner was arranged prior to the meeting, which Dr. Werner addressed, and it will be generally conceded that interchange of visits of this description must undeniably spell progress to the foundry industry.

The annual dinner of the Branch, held last December, was quite its usual success, nearly 100 attending. Prof. Sir Harold Carpenter was the guest of honour.

It is a source of pleasure to be able to report a sound financial position. The balance in hand at the end of the financial year last December was £199 1s. 6d., as against £122 5s. 11d. at the end of the previous year.

The closing down of the Engineers' Club is a serious difficulty for the Branch, as it will be necessary for the Council to secure accommodation in another quarter for the meetings to be fixed for next session.

Earlier, Mr. Chairman and gentlemen, I referred to the seven years I have held the office of Hon. Secretary of this Branch. I have done all that I could in that time to add to its good progress, and have thoroughly enjoyed my task. Business, however, must have attention, and with other activities which demand so much time and thought I have considered it best in the interests of the Branch that I should not be re-elected your secretary and treasurer, and I accordingly trust when this office is about to be filled you will consider another member who is willing to carry on the work of the Branch.

The Junior Section associated with the London Branch continues to flourish, and every praise and encouragement is due to those, particularly Mr. P. Ellis, who work so assiduously for it.

In conclusion, I would like to thank the Council and every member of the Branch for their loyal support and valued friendship during the past seven years. I shall continue to have the Institute and particularly the London Branch and its work deeply at heart, and to offer assistance in any direction whenever required.

The report having been adopted, the Chairman commented upon the success of the year's work, and expressed thanks to Mr. Sommerfield for his great efforts on behalf of the Branch. The report was unanimously adopted, without discussion.

Election of Officers.

The CHAIRMAN proposed that Mr. A. F. Gibbs be elected President of the Branch for the ensuing year, as recommended by the Council. He reminded the meeting that Mr. Gibbs was one of the earliest members of the Branch, that he attended its meetings as regularly as business would permit, and that he was very anxious to further its interests. Mr. Bartram seconded, and Mr. Gibbs was unanimously elected.

Mr. H. C. Dews was elected Senior Vice-President, and Mr. H. G. Sommerfield (the retiring Hon. Secretary) Junior Vice-President, whilst Dr. A. B. Everest was elected Honorary Secretary and Treasurer.

The members of the Council who retired by rotation were Messrs. Bagshawe, Bartram and Hand, and they were nominated by the Council for re-election. Mr. Hand, however, intimated that he would like to retire, and Messrs. Bagshawe, Bartram and Kain were accordingly elected.

On the motion of Mr. V. C. Faulkner, seconded by Dr. Everest, Messrs. Gardom, Dews, Lake, Cree and Wares were elected as representatives to the General Council.

Votes of Thanks.

MR. W. B. LAKE (Past Branch-President) proposed a very hearty vote of thanks to Mr. H. G. Sommerfield for the great work he had done on behalf of the London Branch during the seven years in which he had carried out the duties of its Hon. Secretary.

MR. A. R. BARTLETT (Past Branch-President) seconded, and also paid a tribute to Mr. Sommerfield for his great work.

The CHAIRMAN, who supported the resolution, said it was difficult adequately to express the gratitude of the Branch to Mr. Sommerfield. Its organisation had depended upon him, and it was a very great pleasure to be able to support the vote of thanks to him.

The vote of thanks was carried with acclamation, and Mr. Sommerfield briefly responded.

MR. H. C. DEWS (Senior Vice-President), proposing a hearty vote of thanks to Mr. Gardom, the retiring Branch-President, for his services during the past year, said that within his recollection the Branch had had no worthier President. There had been no man whose occupancy of the chair had been appreciated more than that of Mr. Gardom, and there was no one in the Branch who would not be glad to join in this expression of thanks to him.

The CHAIRMAN, returning thanks, said he had done his best on behalf of the Branch during his term of office, but would have liked to have done more. He took the opportunity again to thank the members for the manner in which they had supported him, and assured them that he had no intention of retiring from active membership of the Branch.

MR. DEWS also proposed a very hearty vote of thanks to Mr. Ronceray (of the French Foundry Association), Mr. A. S. Beech and Mr. H. G. Sommerfield, who, by their organisation of the visit which the members of the Branch had paid to France in March, 1930, had made that visit possible. The visit had been educative and entertaining in the highest degree. Mr. Ronceray had been indefatigable in his efforts to ensure the comfort of the members who had attended, and had been responsible for the hospitality which had been extended to them in France, whilst in addition he had acted as a liaison officer between the officials of the Branch and the officials of the works which the members had visited in France. Mr. Beech had been responsible for a great deal of the organising work, and had done it so admirably that the programme had been followed from beginning to end without a hitch. Throughout the tour he had been a friend indeed. Mr. Sommerfield, as usual, had been responsible for the spade work, and had done it so well that no one had noticed that it had been done.

The vote of thanks was seconded by Mr. Kain and supported by the Chairman, and was carried with acclamation.

MR. SOMMERFIELD acknowledged the vote of thanks, and said he had written to Mr. Ronceray and Mr. Beech expressing the deep thanks of the Branch for all they had done.

The Extension of the Institute's Activities.

MR. V. C. FAULKNER then addressed the meeting on the question of extending the activities of the Institute in the direction of investigating problems of importance to the industry through the media of committees and sub-committees, the members of which would maintain contact with each other largely by means of correspondence, very much on the lines followed by the American Foundrymen's Association.

On the certificates of membership of the Institute, said Mr. Faulkner, the two main

objects of the Institute were set out. The first was:—

"To promote the intellectual welfare of its members by periodical meetings for reading and discussing scientific papers on subjects connected with the foundry and allied industries, and such other matters as may be considered within the scope of the special authority."

He submitted that the Institute was doing that very well. The second object was:—

"To initiate, conduct and supervise researches into the science and technology of the art of metal and alloy production, casting and working. Organise and conduct or advise on means and systems of education for all or any grades of operatives and workers in the art and craft of metal casting, and to collect and distribute information on the science and art of founding and allied subjects."

American Conditions.

It was this second object that the Institute was only just touching the fringe of, but the matter was engaging the very serious attention of the General Council of the Institute. It had been noted that the American Foundrymen's Association—which catered for a Continent rather than a country—had 53 committees, supplemented by another 50 sub-committees. If one added up the membership of each of the technical associations in Europe one would find that they were far stronger than the American Association. The activities of the American Association, however, were very extensive, and were certainly far greater than those of the British Institute. In order to understand the conditions in America one must appreciate that distances there were far greater than in this country. For example, New York was nearer to London than to San Francisco. Distance, however, had had the effect of making the Americans excellent correspondents, and the work of the committees and sub-committees of the American Foundrymen's Association was carried on largely by means of correspondence. Herein lay the essential success of the projected extension of the work of the Institute of British Foundrymen. In general, foundrymen had neither the time nor the money to be able to travel to any very great extent; therefore, if the projected scheme for the carrying out of investigations by committees of members of the Institute were to be a success, correspondence would have to be relied upon to a great extent.

The new project before the Institute was the creation of the President, Mr. Wesley Lambert. It consisted primarily of creating an omnibus Technical Committee, the duties of which would be to form committees to deal with specified subjects. Presumably it would be up to the various branches of the Institute to suggest to the Technical Committee subjects for the investigation of which sub-committees might be formed, and the Technical Committee, on receiving any such suggestion, would decide whether the subject was of national or of purely local interest, and whether its investigation would be of value to the industry. If it were, then a committee or sub-committee would be formed to make the investigation.

It seemed obvious that there should first be formed at least five main committees, to deal with:—(1) Grey iron castings; (2) malleable iron; (3) steel castings; (4) non-ferrous alloys, and (5) light alloys. Sub-committees could then be formed to deal with particular branches of these various subjects. Obviously, Committee No. 1 was capable of carrying a large number of sub-committees, to deal with such matters as:—(*a*) Light castings; (*b*) pipe making; (*c*) alloyed cast iron; (*d*) high-duty cast iron; (*e*) standardisation of equipment, and (*f*) test bars.

There was also a demand for standardised procedure and practice on some other matters, and much good might result from the deliberations of committees on:—(6) Foundry costing; (7) pattern standardisation; (8) moulding sands, and (9) trade customs.

Advisory Activities.

With regard to light castings, he exhibited a small specification for "Baths, Slipper, Cast Iron," published by the Inter-Departmental Works Committee—a Government Department—and pointed out that the foundrymen had had as a national organisation nothing to do with its preparation. Further, he exhibited a number of pamphlets or booklets, dealing with such subjects as better foundry practice, buildings, the merchandising of foundry products, auxiliary equipment for saving man-power, production equipment, pattern storage, getting castings out to schedule, planning and controlling production and re-organisation, and so on. These were produced by the Metropolitan Insurance Company of America, who stated that there were many foundrymen holding their policies, and they produced these booklets as a form of service to those policy holders. All these were subjects which the Institute might usefully study; indeed, it was imperative that it should.

With regard to pipe making, he pointed out that there existed a British Standard Specification which was so exacting that it precluded economic export to countries whose specifications demanded less. That matter needed study.

In a reference to the alloyed cast irons, he pointed out that Dr. Everest had been requested to outline a specification for welding rods for nickel cast iron, and no doubt he, too, would welcome the help of a committee in this connection, if such existed.

Standardisation of Patterns.

As to the standardisation of patterns, it was recalled that at the last meeting of the General Council of the Institute there was considered a demand from an Australian authority, through the British Engineering Standards Association, that the Institute should advise as to the colours which should be used for painting drawbacks, surfaces to be machined, and so on. The General Council had appointed two gentlemen to consider the matter, and had every confidence in them, but it would be a help to them to have a committee behind them. He personally would suggest that we in this country should adopt the American standard. The Americans had spent much time on the study of this matter, and it could be taken for granted that if the Institute adopted the American system, that system would be standardised throughout the whole of the English-speaking nations and probably throughout the whole world. All that was needed was the Institute's cachet.

With regard to test bars, he recalled that the Institute had had a Test Bar Committee working for some time, and its work had been excellent. At the present time, however, a specification was being prepared by the British Admiralty, but the Institute was not being consulted. The Institute of British Foundrymen was a national body, representing about 35 per cent. of the foundries of the country, and if it said that the specification was right its judgment would carry weight. The position was, however, that the Association responsible for its preparation had a membership of about 5 per cent. of the foundries of Great Britain, and the specification was being objected to by associations representing perhaps 2 per cent. of the foundries of the country.

Discussing further the importance of pattern standardisation, he said he believed that in the United States there were only about a dozen standard patterns for bath tubs, and this number covered the whole of the requirements for the domestic and export trade of the United States. On the other hand, there was not a foundry in Great Britain which did not make double that number of patterns for these articles. Again, he felt perfectly sure that six standard patterns for colliery tub wheels would cover the requirements of any colliery existing or likely to be put into operation in this country; yet there were hundreds of patterns used for colliery tub wheels. A complete set of patterns for builders' castings numbered something like 7,000; that was ridiculous, and such a state of affairs did not help us to compete in foreign countries.

Moulding Sands.

The problem of moulding sands was another in connection with which the Institute could render great assistance. He had received only that morning, from the British Cast Iron Research Association, a series of recommendations for a standard practice for Great Britain, and he believed that if it had the cachet of the Institute it would be generally accepted. The Institute was the body which should advise, and the Research Association should do the work; indeed, the Research Association would welcome the Institute's advice, and if it had that advice it would feel that it had a wider basis.

A committee might well be appointed by the Institute to deal with the problem of trade customs. Some of the members might say that the Institute had nothing to do with that matter, but he submitted that it had. A report on the technical aspects of the customs of the trade would certainly be welcomed by manufacturers. It was not in the interests of founders to guarantee castings against consequential damage. A man might offer a sixpenny malleable casting, for instance, and guarantee its softness, not realising that one of those castings might smash a milling cutter costing £20. Again, there was a case in which a casting, the cost of which was, perhaps, a few hundred pounds, was found to be defective. The casting was supplied for use on a ship, and the supplier was mulcted in damages amounting to thousands of pounds because the ship could not proceed on its voyage at the proper time as the result of the defect. It was up to the technical men in the industry to make clear to commercial men the real import of supplying defective castings.

Surely, from the 2,000 members of the Institute, nine committees could be appointed, as he had suggested. Perhaps one could not expect the directors of important iron and steel foundries to serve on the Executive Committee, the Finance Committee, the Literature Committee, and so on, but they could serve on committees dealing with subjects which were germane to their productions. It should be distinctly understood.

Finally, he drew attention to the fact that the membership of the American Foundrymen's Association had increased by leaps and bounds since it had instituted its intensive committee system. The actual creation of technical standards and recommended practices was work definitely germane to technical associations, and modern intelligent appreciation of their place in the make-up of present-day civilisation demanded that they must play their part or disappear.

Discussion.

Mr. W. B. Lake (Past Branch-President) said he believed that the project for the formation of technical committees in the Institute, described by Mr. Faulkner, had been suggested because, when the old Test Bar Committee had completed its work, there had been a desire to substitute another committee. It was true that, as Mr. Faulkner had stated, one of the objects of the Institute was the prosecution of research, and that that object had not received the same attention as had other objects, but it must be remembered that research was a very costly business, and the financial position of the Institute was not sufficiently strong to enable it to carry out original research. Mr. Faulkner had struck the happy mean, however, when he had urged that much could be done towards achieving the main object—of improving the products of the foundry—by correspondence committees. So far as he could see, that was the only way in which the Institute could promote research. He gathered that the function of the main Technical Committee to be formed within the Institute was to form committees, and to leave those com-

mittees to deal with certain subjects and investigate those aspects of the subjects which they considered most important. He hoped something tangible would result from the Annual Convention of the Institute, to be held in Middlesbrough in June.

How the Scheme is to Function.

The CHAIRMAN said that each Branch of the Institute had been asked by the General Secretary to nominate one or two members for service on the main Technical Committee, and the general view of the members of the Institute's Council was that the Technical Committee would be asked to have particular subjects investigated; then that Committee, being representative of all the Branches, would be able to recommend the most suitable men in the various Branches for appointment to committees which would deal with these subjects.

MR. A. R. BARTLETT (Past Branch-President) said he also had gathered that the procedure would be as stated by the chairman. He understood that the existing Test Bar Committee would change its title and would become the main or "Investigation" Committee; suggestions would be made to that committee as to the subjects which might be worthy of investigation, and when that committee considered it advisable to investigate any subject it would appoint a sub-committee for the purpose. The members of the main committee would be able to select from the various Branches those who were best qualified to investigate any particular subject, and appoint them to serve on a sub-committee; the findings of each sub-committee would be submitted to the Investigation Committee for approval and for submission to the country as standard practice.

DR. A. B. EVEREST (Branch Hon. Secretary) suggested that one of the functions of the Technical Committee should be the correlation of existing knowledge, because in his experience a tremendous amount of the research work carried out by private individuals and firms was buried, either because the results were negative or because those responsible for it considered it to be of no general interest. If the proposed new Committee of the Institute, with the aid of its sub-committees, could collect the results of such work by sending out questionnaires, or by similar means, the task of recommending standard practices would be very greatly assisted.

MR. H. C. DEWS (Vice-President of the Branch), speaking as a purely technical member of the Institute, said that any movement for the formation of committees to pursue purely technical objects had his wholehearted and enthusiastic approval. The carrying out of such work was something which had been neglected by the Institute far too long. The Institute's membership comprised a body of men representing, he supposed, the leading brains in the foundry industry in the country, and it seemed a pity that it had not used collectively the material at its disposal for the "moulding" of the technique of foundry work. He believed that, if the proposed new Technical Committee were formed, the Institute would be taking thereby the first step in a very important movement. It was worth emphasising that that Technical Committee would select the personnel of its sub-committees not merely from the General Council of the Institute but also from the rank and file of the Institute's members, for that would represent another very important advance. Thus, in drawing up specifications, correlating knowledge and pursuing research the Institute would have the benefit of the experience not only of its leaders but also of those quiet members of the Institute, who did not figure on its Councils in the ordinary course of events, for many reasons known only to themselves, and this new project was one which all members should give very careful consideration. He suggested, also, that members of the Branch who were not members of the General Council or of the Branch Council should write down their views with regard to the project and send them to the Branch-Secretary or to any member of the General Council. There was no necessity to take much trouble to write formal recommendations, but their opinions would be greatly valued by the members of the General Council, who were anxious to start the scheme going.

The CHAIRMAN said that the suggestion made by Dr. Everest, that the Technical Committee should devote some attention to the correlation of existing knowledge, was a very valuable one, and added that if the Committee did nothing else but that it would have rendered a service of great value to the industry. Frequently research workers paid no further attention to researches which had yielded negative results, but it must be appreciated that negative results were often as important as positive results, because, apart from the fact that somebody else might reap some advantage from the work, the fact that other people knew the results to be negative would enable them to save a quantity of time which otherwise they might devote to the carrying out of the same work themselves. If one knew that the results of certain work had proved to be negative—provided those results had been confirmed—one was able to start subsequent work halfway along the line, instead of having to start from the very beginning.

A Vote of Thanks.

The CHAIRMAN proposed, a hearty vote of thanks to Mr. Faulkner for his address and to the directors of THE FOUNDRY TRADE JOURNAL for having permitted the Branch to hold its Annual General Meeting in their offices, and also for having allowed the Branch Council and the Junior Section to use the offices during the session for their meetings. The vote of thanks was seconded by MR. W. B. LAKE and was carried with acclamation.

The meeting then closed.

Important Foundry Extension.

Extensions running into an expenditure of £20,000 were opened recently at the establishment of Messrs. Hepworth & Grandage, Limited, ironfounders and engineers specialising in the Hepolite piston and other automobile parts, of St. John's Works, Bradford. The opening ceremony was performed by the Lord Mayor of Bradford (Alderman Angus Rhodes). Mr. G. R. Hall Caine, M.P., the chairman of the company and son of the famous Manx novelist, presided. The extended buildings are modern and model in every sense of the word; roomy, light and airy, and permit of enlargement of all departments at the works. The undertaking was founded 22 years ago, in Aldermanbury, Bradford. A move was made to Manchester Road to meet increasing business, but after three years this place was totally inadequate, and the business moved to St. John's Works in 1917. The extension just completed is the eighth since the firm began. The firm make the Hepolite pistons, piston rings, valves, gudgeon pins, etc., and export to all parts of the world. Despite the widespread industrial depression, this firm are increasingly busy.

B.S. Specification for Tramway Axles.—The British Engineering Standards Association have issued a revised edition of Specification No. 102 for Tramway Axles. The new issue has been enlarged, and now contains separate specifications for axles of three different qualities of steel. This extension has been made in view of the increasing tendency amongst some engineers to adopt axles with a somewhat higher tensile strength, and this demand has been met by providing for axles of high-tensile carbon steel and nickel-chrome steel. The specification as revised will now meet the requirements of all tramway undertakings. Copies of this specification (No. 102—1930) can be obtained from the Association Publications Department, 28, Victoria Street, Westminster, S.W.1. Price 2s. 2d., post free.

Continental Steel Cartels.

Position of British Industry.

Reports have been circulated from Paris this week to the effect that the British steelmakers are now more disposed to come to some agreement with the Continental Steel Cartel. It is said that, having regard to the competition of Belgian and French works, the British steelmakers might feel inclined to enter into an agreement under the terms of which, while making concessions in foreign markets, they would be enabled to strengthen their position in the home market.

The committees appointed by the Continental Steel Cartel to study the various questions involved relative to the adhesion of the British industry have submitted to the Managing Committee of the Cartel elaborated proposals regarding the organisation of the British outlet for semi-products and finished steel. A full agreement has been reached within these committees, also, as regards the conditions to be offered to the British exporting merchants. Shortly there is to be a meeting with the British merchants in order to negotiate with them the conditions of their collaboration with the selling comptoirs. Subsequent meetings of the Continental Steel Cartel took place at Brussels on Saturday, May 31.

Wire Rod Syndicate.

The Wire Rod Syndicate, at a meeting held at Antwerp recently, decided to reduce the total sale allotments of all the constituent groups from 500,000 tons to 425,000 tons for the third quarter of the current year. While the f.o.b. prices were left without change at between £6 5s. and £6 10s., according to the sizes, the Syndicate decided to reduce the c.i.f. price for deliveries to Japan by 5s. to £7 2s. per ton.

Hoop Iron.

A meeting was held last week of representatives of the groups incorporated in the hoop-iron distribution office which has been formed within the organisation of the Continental Steel Cartel. The object was to discuss further certain questions which it was impossible to settle at the recent meeting in Brussels, particularly the control of sales of special products and their prices. A reduction in the minimum prices for hoops is not contemplated.

Contracts Open.

Alexandria.—Shipbuilding materials, including plates, angles, tees, bars and rivets, for the Ports and Lighthouses Administration, Alexandria. The Department of Overseas Trade. (Reference A.X. 9,615.)

Bexleyheath, June 14.—Sewer ironwork, lamp columns, etc. Mr. W. T. Howse, surveyor, Council Offices, Bexleyheath.

Bridgend, June 11.—Provision and laying of cast-iron water mains, for the Mid-Glamorgan Water Board. Mr. E. W. Davies, engineer and manager, Water Board Offices, Bridgend. (Fee £1 1s., returnable.)

Cairo, July 26.—Supply and erection of a cooling tower, including construction of a well and basin, electrically-driven and centrifugal pumps, electric motors, switchgear, etc., for the Ministry of the Interior. The Department of Overseas Trade. (Reference A.X. 9,627.)

Chelmsford.—2,500 yds. of 18-in. and 3,600 yds. of 12-in. dia. cast-iron pipes and specials. Mr. F. N. Howes, engineer and manager, Gasworks, Chelmsford.

Leeds, June 16.—(1) 100 tramcar bodies; (2) 100 tramcar trucks, including wheels and axles; (3) 100 pneumatic brake equipments; (4) 100 electrical equipments, for the Tramways Committee. Mr. R. L. Horsfield, general manager and engineer, 1, Swinegate, Leeds. (Fee £2 for each specification, returnable.)

London, S.E., June 17.—27 locomotive engines and tenders, XA type, 5 ft. 6 in. gauge, for the India Store Department, Belvedere Road, Lambeth, London, S.E.1. (Fee 5s., non-returnable.)

Spalding, June 13.—Cast-iron water mains, etc., for the Spalding Rural District Council. Mr. A. K. Maples, clerk, Spalding. (Fee £5, returnable.)

A SCHEME OF CAPITAL REDUCTION and reorganisation is proposed by the directors of Messrs. George Wostenholm & Son, Limited, cutlery manufacturers, Sheffield.

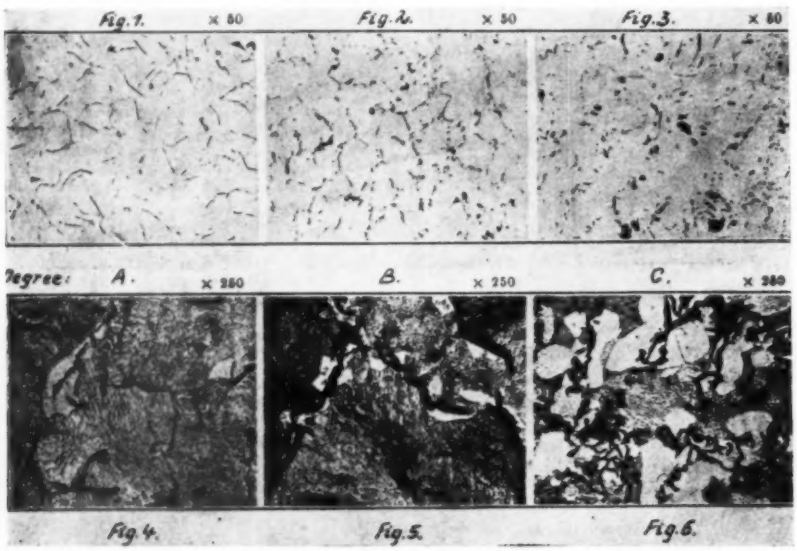
Superheating Cast Iron.

P. Bardenheuer and K. L. Zeyen have recently made some investigations into the effect of superheating upon the structure and the mechanical properties of cast iron.* Engineering cast-iron scrap and grey pig-iron were used as raw materials. After having been melted in a high-frequency induction furnace, mild-steel scrap and ferro-alloys were added to attain definite chemical compositions. Each heat (about 22 lbs.) was kept for fifteen minutes at the following three degrees of superheat:—A, at 1,350 to 1,380 deg. C.; B, at 1,460 to 1,500 deg. C.; and C, at 1,580 to 1,630 deg. C. After each treatment one-third of the heat was tapped into a ladle, and two bars of 1.18 in. dia. and 25.6 in. long were cast in dry-sand moulds at about 1,350 deg. C. The temperature was measured with a colour pyrometer.

Experimental Series I.—The samples contained from 2.5 to 3.4 per cent. of carbon, from 1.1 to 2.3 per cent. of silicon, and about 1.0 per cent. of manganese; the sulphur and phosphorus contents were very low (0.04 per cent. P and 0.015 per cent. S). It was found that with 3.4 per cent. of carbon both the transverse strength and the tensile strength increased with the increasing degree of superheat. With the samples containing 3.0 per cent. of carbon and below, the transverse strength gradually decreased with the increasing degree of superheat; the tensile strength, however, heavily decreased at the degree B, and slightly increased at the degree C. The deflection gradually decreased with all the samples. The metallographic examination showed that, with the sample containing 3.4 per cent. of carbon, the graphite, though refined by superheating, was always present as small flakes evenly distributed in the matrix. With the other samples, at the degrees of superheat B and C, the graphite forms a continuous network consisting of small flakes or eutectic graphite. The formation of this network may be explained by that, because of the low carbon content, all the graphite is dissolved during superheating the iron. On cooling, very many mixed crystals, low in carbon, separate from the melt, and the liquid remainder in the interspaces supersaturated in carbon decomposes into ferrite and graphite on solidification. This form of crystallisation is favoured by the low sulphur and phosphorus contents. The experimental data of heats 1 and 4, with the highest and lowest carbon contents, are recorded in Table I. Figs. 1 to 3 show the shape and the distribution of the graphite of Heat No. 4, Figs. 4 to 6, the microstructure of the same heat after etching.

Experimental Series II.—The samples contained from 2.3 to 3.4 per cent. of carbon, from 1.5 to 2.5 per cent. of silicon, and about 1.0 per cent. of manganese. As engineering cast-iron scrap alone was used as raw material, the sulphur and phosphorus contents were high (0.4 per cent. P and 0.08 per cent. S). The furnace was lined with corundum, and the molten iron was covered with a layer of corundum; in this way the chemical compositions of the heats could be kept unchanged during melting and superheating. The experimental results are about the same as that of series I. With more than 3.2 per cent. of carbon the transverse strength increased with the increasing degree of superheat; the tensile strength did not change materially. With the samples containing 3.2 per cent. of carbon and less, the transverse strength decreased, the tensile strength did not change materially or increased. The deflection gradually decreased with all the samples. The graphite was refined by superheating; a continuous network of fine eutectic graphite, however, could not be found, but with some samples near the edge. This may be attributed to the high sulphur and phosphorus contents which favour the normal crystallisation. At the degrees of superheat B and C, the samples containing 3.2 per cent. of carbon and less showed a tendency to dendritic crystallisation which affects the transverse strength, but not the tensile strength.

The results of the two series of experiments show that superheating does not improve the strength properties of cast iron, but when the total carbon content is about 3.2 per cent. and over. When the carbon content is below that figure, the transverse strength decreases; the same is the case with the tensile strength of irons high in sulphur and phosphorus. Therefore, excessive superheating of high-duty cast iron must be avoided. Irons low in carbon, on the other hand, require a rather high casting temperature, and, therefore, it is necessary to look out for remedies which may eliminate the bad effects of superheating. These effects are that, because of the absence of graphite nuclei, the separation of the graphite from the melt is retarded, and the melt is undercooled. On solidification, a great number of mixed crystals are formed, surrounded by a continuous network of finely-divided graphite and ferrite. There are three remedies which may prove successful:—(1) Adding elements which favour the graphitisa-



Figs. 1 to 3.—Shape and Distribution of the Graphite after Heat No. 4.
Figs. 4 to 6.—Microstructure of the same Heat after Etching.

Table I.—*Properties of Cast Iron after Superheating.*

Heat No.	Degree of superheat.	Transverse strength. T./sq. in.	Deflection. In.	Tensile str'ngth T./sq. in.	Brinell number	Chemical. C. Per cent.	Gr. Per cent.	Si. Per cent.	Composition. Mn. Per cent.	P. Per cent.	S. Per cent.	Cr. Per cent.
					Series I.							
1	A	26.3	0.571	14.9	177	3.44	2.81	1.10	0.87	0.038	0.015	—
	B	29.2	0.606	15.4	186	3.34	2.78	1.21	0.88	—	—	—
	C	30.2	0.378	18.3	216	2.79	2.15	1.82	1.05	—	—	—
4	A	43.6	0.689	23.7	234	2.53	1.84	2.22	0.93	0.043	0.012	—
	B	34.0	0.413	17.3	230	2.52	1.92	2.25	0.94	—	—	—
	C	32.1	0.370	18.0	217	2.66	1.82	2.35	0.95	—	—	—
					Series III.							
10	A	27.0	0.413	15.9	217	2.79	1.90	2.38	1.05	0.076	0.036	—
	B	26.8	0.374	15.7	212	2.73	1.95	2.37	1.04	—	—	—
	C	35.1	0.433	19.5	218	2.81	2.02	2.54	0.91	—	—	—
					Series IV and V.							
11	A	19.2	0.394	10.2	189	3.09	2.43	3.98	0.94	0.075	0.029	—
	B	25.3	0.492	10.7	182	3.05	2.47	4.00	0.93	—	—	—
	C	25.0	0.503	10.7	171	3.13	2.59	4.05	0.92	—	—	—
14	A	25.5	0.283	17.6	227	2.52	2.13	3.85	0.94	0.037	0.069	—
	B	27.1	0.355	17.5	227	2.54	2.09	3.84	0.96	—	—	—
	C	32.4	0.347	17.1	238	2.57	2.05	3.72	0.93	—	—	—
15	A	20.1	0.315	12.6	227	2.07	1.50	3.71	1.01	0.059	0.026	—
	B	19.4	0.236	11.9	247	1.99	1.37	3.68	0.98	—	—	—
	C	27.2	0.256	18.7	293	2.00	1.27	3.65	0.93	—	—	—
16	A	26.3	0.370	14.0	241	2.54	1.74	2.00	1.13	0.14	0.135	—
	B	31.4	0.386	18.4	237	2.51	1.66	1.97	1.07	—	—	—
	C	34.7	0.433	23.9	248	2.54	1.71	2.07	1.07	—	—	—
					Series VI.							
17	A	24.5	0.413	13.7	198	3.73	2.50	1.40	0.55	0.074	0.042	0.56
	B	24.3	0.437	13.8	196	3.75	2.48	1.39	0.52	—	—	0.56
	C	25.0	0.484	13.7	180	3.77	2.68	1.43	0.51	—	—	0.56
20	A	26.3	0.354	15.1	250	2.53	1.65	2.45	0.61	0.061	0.051	0.60
	B	25.7	0.303	15.8	265	2.51	1.61	2.49	0.59	—	—	0.60
	C	28.0	0.315	18.8	257	2.64	1.74	2.42	0.56	—	—	0.57

* "Die Giesserei," 1929. No. 33.

tion, immediately before pouring; (2) increasing the contents of graphitising elements in the raw material; (3) adding elements which suppress the excessive formation of large mixed crystals.

Experimental Series III (first remedy).—The samples contained from 2.8 to 3.0 per cent. of carbon, from 2.0 to 2.5 per cent. of silicon and about 1.0 per cent. of manganese. About half of the silicon content was added to the melt as silicon powder in the ladle immediately before pouring. It was found that both the transverse strength and the tensile strength did not change materially at the degree of superheat B; at the degree C a remarkable improvement took place. The deflection increased with the increasing degree of superheat. An effect upon the graphite and the structure could not be stated; the graphite being always present as small flakes. Dendritic crystals did not appear. The strength values, however, at the degree of superheat A were remarkably lower than in the case when the definite silicon content was charged with the mixture. The experimental results of heat No. 10 are recorded in Table I.

Experimental Series IV and V (second remedy).—The samples contained from 2.0 to 3.0 per cent. of carbon, from 3.3 to 4.0 per cent. of silicon and about 1.0 per cent. of manganese. Both transverse strength and tensile strength did not change materially with the increasing degree of superheat, or increased slightly. The same was the case with deflection. The graphite was present as small flakes evenly distributed in the matrix, which consisted of pearlite and ferrite. Some of the experiments are recorded in Table I. It was not only with the sample containing 2.0 per cent. of carbon and 3.7 per cent. of silicon (Heat No. 15) that a network of finely-divided graphite and dendritic crystals appeared; this sample showed very bad strength properties. At the degree of superheat A the sample containing high-sulphur and phosphorus contents (Heat No. 16) showed a large number of dendritic crystals which, however, decreased with the increasing degree of superheat, the strength properties thereby being improved. Because of the great tendency to dendritic crystallisation of irons low in carbon, the authors are of opinion that with a normal silicon content the carbon content should not be below 2.5 to 2.7 per cent.

Experimental Series VI and VII (third remedy).—The melts contained from 2.5 to 3.7 per cent. of carbon, from 1.4 to 2.5 per cent. of silicon, 0.5 per cent. of manganese and 0.5 per cent. of chromium. The transverse strength did not change materially with the increasing superheat, the tensile strength increased slightly. The absolute strength values, however, were rather low (see Heats Nos. 17 and 20), which can be attributed to the brittleness of the iron-chromium mixed crystals. Increasing the manganese content to 1.0 per cent. gave the same results. In all the samples the graphite was refined by superheating, being present as small flakes. The samples low in carbon showed small areas of eutectic graphite.

Brickwork.—Common brickwork, inclusive of mortar, weighs approximately 116 lbs. per cub. ft. Blue brickwork weighs 140 lbs. per cub. ft; firebrick (unjointed) approximately 122 lbs. per cub. ft.

World Power Conference in Berlin.—The Publication Department of this Conference, to be held this month, reports that 36 countries have already announced their intention of sending representatives. Some 400 reports are to be submitted to the Conference, which will be summarised in 34 general reports by German experts in German. Special arrangements will be made to have the discussion translated on the spot, so that the remarks of the various speakers will be heard practically simultaneously in German, English and French. Further information and copies of the papers to be submitted may be obtained (the latter against payment), from Geschäftstelle, Berlin, N.W.7, Ingenieurhaus, to which all notices of attendance, etc., are to be addressed.

Synthetic Cast Iron made in the Electric Furnace.

A process of producing synthetic cast iron in the electric furnace, which is in use in the foundry of Messrs. Brown-Boveri, is described by Nathusius in "Die Giesserei," Vol. 17, No. 43. The process is based on the fact that the carburisation of iron takes a certain time and cannot be accelerated by increasing the supply of electric energy.

The electric furnace used has a capacity of 3 to 4 tons, and is provided with a shaft. On the bottom of the furnace a layer of coarse coke is given, and thereon the raw material is put crushed and well mixed with the carburising medium in order to get a large surface of contact. Petroleum coke is used as carburising medium; a surplus of 10 per cent. over the desired carbon content is added. The cross-sections of the electrodes and the voltage are so chosen that the arcs burn on the coke layer only and do not climb the shaft upwards. Thus, on its way downwards, the iron is slowly preheated, and finally is in a pasty state which is most favourable to take up the carbon. In the zone of the highest temperature, immediately above the coke layer, the iron is melted and drops through the coke on the bottom of the furnace. The molten iron has the desired carbon content; beneath the coke layer no further carburisation takes place. The coke layer floats on the molten bath, separating the raw material from the finished product. Besides this, it retains the unconsumed carburising medium, which is taken up by the molten iron drops on their way through the coke; in this way the final carburisation is effected. According as the iron is melted, further raw material is charged in the shaft. The slag used is a basic lime slag. The silicon and manganese contents of the iron are regulated by adding ferro-alloys to the bath. As there is a reducing atmosphere in the furnace, no appreciable loss in alloys takes place. The energy consumption is 800 to 1,000 kw.-hr. per ton of cast iron containing about 2.6 per cent. of carbon. It is possible to increase the carbon content up to 3.5 per cent., which is associated with an increased consumption of electric energy and time.

In Table I the mechanical properties of some melts are recorded. The transverse test was made with bars of 1.18 in. dia. and 23.6 in. long in the as-cast condition. The tensile strength was examined with the same bars after having been machined to 0.787 in. dia. The metallographic examination showed that the matrix of samples Nos. 3 and 13 consisted of very fine lamellar pearlite. The graphite of sample No. 3 was eutectic, that of sample No. 13 consisted of thin flakes evenly distributed in the matrix. As the strength properties of the two samples are nearly the same, the author concludes that, with high-duty cast iron, it is not necessary that the graphite is in the eutectic state, provided that it does not consist of thick flakes unevenly distributed. A distinct relationship between the microstructure and the strength properties could not be stated. This is rather the case with the chemical composition, as the tensile strength increases with the decreasing carbon content.

The synthetic cast iron is especially used for parts of steam turbines and compressors where great density together with high strength are required. Furthermore, piston rings with a thickness of 0.118 to 0.197 in. are cast. The chemical composition is regulated according to the wall thickness of the castings. For a thickness over 1.97 in. the carbon is increased to 3.0 per cent. and the silicon decreased to 1.4 to 1.6 per cent. with about 0.5 per cent. Mn.

TABLE I.—*Mechanical Properties of Some Melts.*

Melt. No.	Chemical composition.						Transverse strength.	Tensile strength.	Brinell number.
	T.C.	Si	C+Si	Mn	P	S	T./sq. in.	T./sq. in.	
1	2.28	3.13	5.41	0.29	0.09	0.020	36.1	27.2	262
2	2.39	2.90	5.39	0.23	0.09	0.017	37.6	24.9	258
3	2.42	2.68	5.10	0.33	0.05	0.015	41.9	28.6	285
4	2.47	3.81	5.28	0.23	0.08	0.025	41.2	28.1	312
5	2.48	3.86	5.34	0.20	0.08	0.017	39.4	27.4	285
6	2.50	2.96	5.46	0.23	0.10	0.019	38.5	27.3	266
7	2.52	3.25	5.77	0.24	0.09	0.020	31.9	24.3	269
8	2.52	3.42	5.94	0.23	0.09	0.016	37.9	24.1	269
9	2.61	3.30	5.91	0.26	0.10	0.020	44.5	26.3	289
10	2.63	3.00	5.63	0.29	0.11	0.022	38.7	23.9	255
11	2.64	2.86	5.50	0.26	0.12	0.023	33.9	24.9	266
12	2.65	3.13	5.78	0.31	0.11	0.022	31.5	25.1	274
13	2.66	2.88	5.54	0.35	0.12	0.014	39.6	25.6	235
14	2.66	3.16	5.82	0.32	0.08	0.016	42.8	30.5	269
15	2.67	3.23	5.90	0.28	0.10	0.016	37.5	22.7	241
16	2.68	2.93	5.61	0.29	0.09	0.017	36.6	23.7	255
17	2.75	3.01	5.76	0.33	0.15	0.022	34.4	24.9	258
18	2.56	3.15	5.71	0.27	0.10	0.019	37.8	25.8	268
19	2.25	3.13	5.37	0.26	0.13	0.014	30.0	20.5	302
20	2.55	3.21	5.76	0.24	0.07	0.022	34.6	27.3	285
21	2.57	3.34	5.91	0.28	0.07	0.020	34.0	21.9	269
22	2.62	3.76	6.38	0.30	0.06	0.010	37.1	23.7	281

A Foundry Workers' Club.

Following extensive alterations, the outstanding feature of which is the provision of a concert hall for 400 people, the Sheffield Foundry Workers' Club and Institute, Attercliffe, was re-opened on May 26 by Mr. A. Short, M.P. for Wednesbury, and Parliamentary Under-Secretary for the Home Office. The gathering, presided over by the president of the club (Mr. J. T. Barker), included Dr. P. Longmuir, Messrs. T. Chadwick (chairman of the Executive Council of the National Union of Foundry Workers), C. D. Pollard (president of the Foundry Trades Technical Society) and Alderman E. G. Rowlinson.

Speaking of the educational facilities provided by the working men's club movement, Mr. Short said that short hours, high wages, and beautiful houses to live in would be of little value without some degree of culture and refinement.

Dr. Longmuir said the foundryman's craft went back to before the Christian era. With regard to educational facilities generally, he knew of none finer than those provided by the Sheffield elementary schools, and he asked them to remember that there was a permanent ladder between the elementary schools and the Sheffield University.

Alderman Rowlinson congratulated the foundryworkers and steelworkers on the way they had collaborated in encouraging a policy of further education as far as the various industries were concerned.

French Ironmasters' Association.

ANNUAL REPORT.

The annual report of the Comité des Forges de France states that on the whole 1929 appears to have been a period of prosperity for the French iron and steel industry, but disquietening symptoms have appeared during recent months.

If the production of pig-iron and steel last year exceeded that in 1928 and reached tonnages which were without precedent, and if the sales in the home market represented 75 per cent. of the output of steel as compared with 67 per cent. in 1928 and 60 per cent. in 1927, the progressive adjustment of the retail prices in France to the new monetary conditions, at the same time as the large fall in the world wholesale prices, have caused international competitive conditions to become more severe, and this situation has been reflected in a considerable reduction in the tonnage exported and in the prices realised.

The report further states that the production of pig-iron throughout the world last year amounted to 91,000,000 metric tons as compared with 84,000,000 in 1928, or a fresh advance of 7,000,000 tons. To this total France contributed 10,364,000 tons, Germany, 13,400,000 tons, Great Britain 7,700,000 tons, Belgium 4,100,000 tons, Luxemburg 2,900,000 tons, and the Saar works 2,100,000 tons, or a total of 41,000,000 tons for the leading producing countries in Western Europe, as against 37,000,000 tons in 1928. On the other hand, the production of the United States increased to 42,000,000 tons as compared with 38,700,000 tons in 1928 and 31,000,000 tons in 1913.

As regards steel—the report states—it may be estimated that the world production last year amounted to 113,000,000 metric tons as against 105,000,000 tons in 1928 and 75,000,000 tons in 1913. In this total the participation of France was about 9,700,000 tons, that of Germany 16,200,000 tons, Great Britain 9,800,000 tons, thus re-occupying the second place, Belgium produced 4,100,000 tons, Luxemburg 2,700,000 tons, and the Saar district 2,200,000 tons. These figures make a total of 45,000,000 metric tons for Western Europe as compared with 42,000,000 tons in 1928 and 32,000,000 tons in 1913. With regard to the United States, the make of steel there reached 55,000,000 tons as against 52,000,000 tons in 1928 and 32,000,000 tons in 1913. The other countries in Europe, as well as Japan, India, Australia and Canada, also made some progress last year.

If the progress of production in France is more particularly taken into consideration, it will be found that between March and December the monthly output of pig-iron remained practically constant at about 880,000 tons. The number of furnaces in blast was 157 in January and October, but only 154 at the end of the year. Concerning the production of steel ingots and castings, it is noted that the monthly output was about 820,000 tons, with slight variations, as compared with a monthly average of 559,000 tons in 1913 within the same frontiers.

Exports and International Competition.

According to the statistics collected by the Association, the deliveries of finished products by the works may be estimated at 6,543,000 tons last year, as compared with 6,257,000 in 1928. To this total the French industry contributed 4,986,000 tons, while the exports to foreign countries aggregated 1,344,000 tons; besides this altogether 213,000 tons were sent to Algeria, the French colonies and protectorates.

According to the statistics of the Customs administration, which include figures relating to the works in the Saar district, the total exports of iron and steel products, including pig-iron and semi-finished steel, amounted to 3,661,000 tons, thus showing a decrease of 772,000 tons compared with 1928. This diminution took place in all products and to all destinations in about the same proportions.

It is quite evident, the report says, that the search for export markets has become increasingly difficult through the general stabilisation of currencies, which has restored to some largely-populated countries all their advantages, and in a certain measure also as a consequence of the financial crisis in the United States; but the present difficulty is, above all, the result of the universal increase in the production of pig-iron and steel, which does not seem to have been followed by the rate of consumption.

The Continental Steel Cartel.

Referring next to the formation of the Continental Steel Cartel in 1926, the report submits that this organisation by itself had been unable to achieve the object aimed at, namely, adjusting the output of steel to the potential requirements of the markets. It was, therefore, imperative to complement the Cartel by the constitution of international selling offices. It was possible to resume the discussions on this subject towards the end of last year, and, pending the definite formation of such new organisations, a provisional convention has been established to regulate, both from the point of view of tonnage and prices, the tonnages of exports of semi-products, joists, channels, zorés, merchant iron and steel bars, plates of over 4.75 mm. thick, hoops and tube strip. But if such organisations permit of the hope of an improvement in sales to foreign countries, the figures clearly show how desirable it is to increase the deliveries to the French colonies and protectorates.

The statistics adduced show that France remains probably the only country where the production of pig-iron is still higher than that of steel, whereas it was so in all countries in 1913. This movement, which is being accelerated year by year, indicates very distinctly the progress which has been made by the manufacture of open-hearth steel. It is therefore not astonishing that all the European countries have been induced to place a restriction on the export of scrap, while at the same time endeavouring to obtain abroad supplies of scrap for their own industries. France is much less strict in this respect than the neighbouring countries and permits the export of considerable quantities of old iron in addition to the fixed contingents. This state of affairs is evidently helped by the terms of the decree relating to the embargo which determines the destination of goods which the French administration is evidently unable to control beyond the French frontiers.

While the Government is preoccupied with the question of the French iron-ore resources—the report states—it would be absurd to allow, to the benefit of competitive industries, the country's resources in scrap to be exhausted, as the use of scrap permits of smelting in the blast furnaces certain inferior ores, and in any case an increase in the production of open-hearth steel would very soon make these resources appear to be inadequate.

After discussing the questions of railway rates, taxes, the Customs tariff, the report proceeds to describe the situation of the iron and steel industries in Great Britain, Belgium, Luxemburg, the Saar district, Germany and the United States.

THERE WAS A RECORD DAY'S IMPORTATION of iron ore at Workington at the beginning of last week, 8,800 tons of Spanish ore for the United Steel Companies, Limited, being brought in two Spanish vessels.

Ancient Egyptian Implements.

At the annual meeting of the Iron and Steel Institute held in London recently, Prof. H. Louis (President) in the chair, SIR H. C. H. CARPENTER and DR. ROBERTSON presented a Paper on "The Metallography of Some Ancient Egyptian Implements." The following is a general consideration of the evidence.

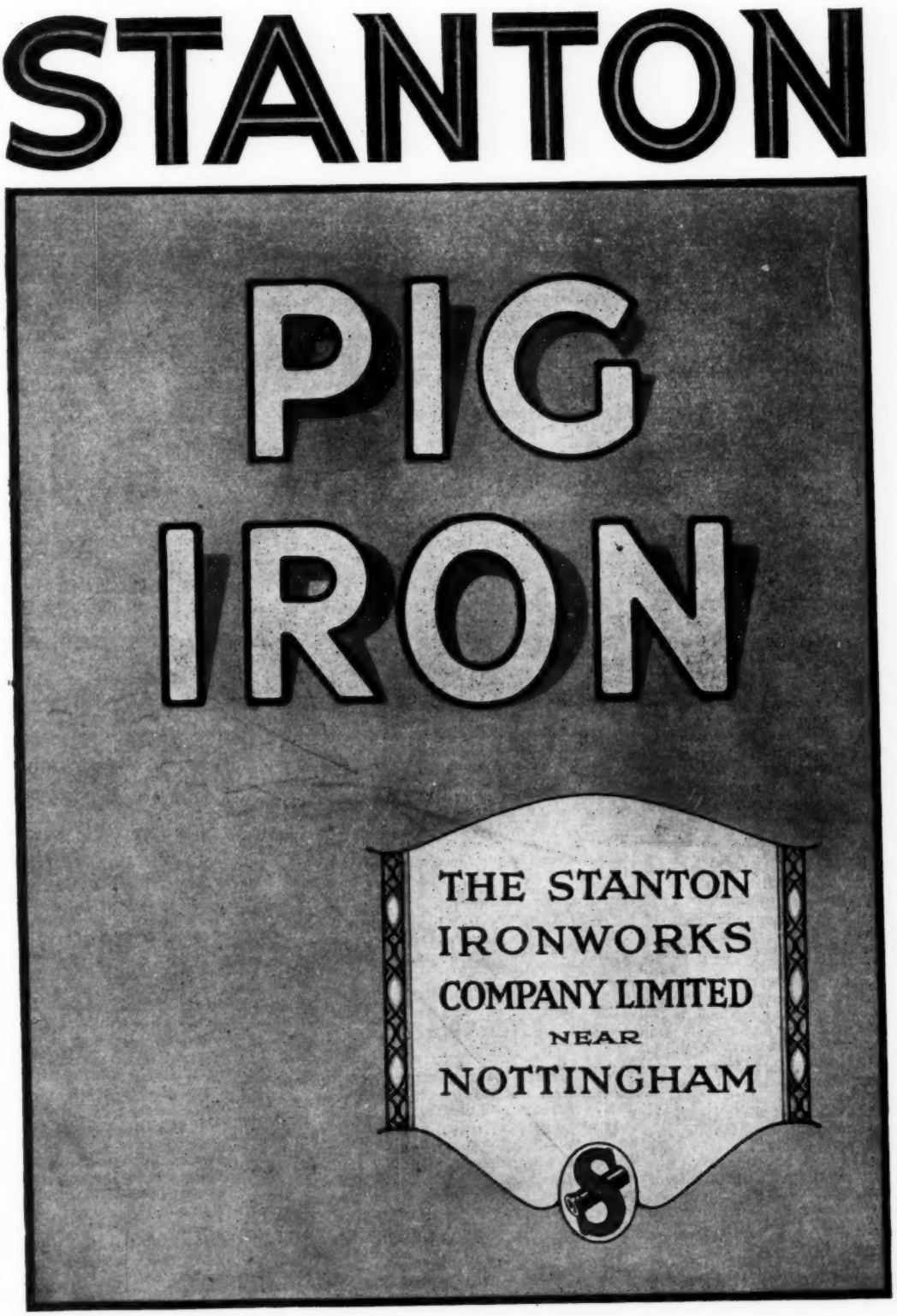
The Egyptian process of extracting iron from its ores was undoubtedly very primitive, and the workers were probably unable to make anything except comparatively pure direct iron always containing slag, and sometimes carbon. In the latter cases, the lump of metal produced during one heat would vary in carbon content from place to place, and, no doubt, there were considerable differences in composition between the products of different heats. Both of these defects are common to all primitive methods of iron manufacture used in Asia, Africa and Europe. But, although their resources in the form of raw metal were limited by the primitive nature of their extraction process, the Egyptians were nevertheless able to produce in small articles a great variety of properties by means of carburisation and heat treatment, and this fact is clearly demonstrated by the results of the present examination of nine representative specimens.

Considering these according to their age, it was observed that the oldest specimens were carburised but not quenched; the next oldest were carburised and quenched; whilst the latest specimen was carburised, quenched and tempered. It appears that the art of heat treatment certainly advanced during the period 1200 B.C. to A.D. 200. It is very doubtful, however, whether this inference has any significance, for as far as quenching is concerned it is quite possible that it was known even at the time when the other specimens were made, but was not used in cooling these small spècimens, which would have been made excessively hard by such treatment. If they were ignorant of tempering, or unable to control its effects, the Egyptians probably only resorted to water-quenching under conditions which did not produce excessive hardness, as, for instance, when the extreme edge of a chisel or axe was immersed in water. If this inference is correct, then it is quite possible that quenching was known even as early as 1200 B.C., and this is supported by the fact that some specimens had been given a refining treatment after carburising.

It may be, however, that tempering was a later art, and was introduced by the Romans. Of all the heat treatments used, this operation would be the most difficult to perform, and for a long time its successful application may have been the secret of a few. This is true, no doubt, to a certain extent of all metallurgical operations, and it makes it difficult to draw conclusions about the relative ages of specimens from a consideration of the skill shown in their manufacture. At the present time there are notable differences in the extent to which the metallurgical knowledge and skill of the community is exhibited by different products, and the same would certainly apply in ancient Egypt.

In the opinion of the authors, it seems probable that the Iron Age did not properly begin in Egypt until the technique of carburising and heat treatment generally had been discovered and well developed, or, to put the matter somewhat differently, it was not until iron had been converted into steels that the Egyptians obtained a range of alloys which were superior in their properties to bronze and capable of more varied applications. In countries, however, where bronze was practically unknown, where notable skill in its manipulation had not been attained, or where the requisite ores were not readily available, the investigation of iron would follow more closely on the first discovery of this metal, and its development be more rapid.

XUM


STANTON
PIG
IRON
THE STANTON
IRONWORKS
COMPANY LIMITED
NEAR
NOTTINGHAM

Trade Talk.

Damage estimated at about £2,000 was caused by a fire which occurred last week in a mill at the Ickles steelworks of Messrs. Steel, Peech & Tozer, Limited.

In order to make way for the Harbour Trust extension of the King George Wharf, Dundee, the Caledon Shipbuilding & Engineering Company, Limited, vacated the Caledon Shipyard on May 28.

Meetings of the debenture stockholders of Messrs. Cammell Laird & Company, Limited, have been called for June 6 to consider a revised scheme in connection with the proposed modification of their rights.

The Friedrich Krupp A.G. is negotiating with the Government of Chile for the construction of a steel plant and blast furnace at Puerto Corral. Reports that the contract has been awarded cannot be confirmed.

The Scottish Manufactured Iron Trade Conciliation and Arbitration Board announce that the net average selling price in March and April was £10 10s. 11.57d. per ton, and in consequence the wages of the workers will remain unchanged.

It is officially announced that the Amalgamated Metal Corporation, Limited, which holds all the shares of the British Metal Corporation, Limited, and Messrs. Henry Gardner & Company, Limited, is about to effect a substantial exchange of shares with the Metallgesellschaft, of Frankfurt.

The Staveley Coal & Iron Company, Limited, have booked orders for 770 tons of 30-in. cast-iron pipes for the Salford Corporation gas department; 650 tons of 10-in., 12-in. and 36-in. pipes for the Leicester Corporation gas department; as well as for 320 tons of pipes for Birmingham and 253 tons for Harrogate.

The Cunard Company recently announced that it was in communication with certain shipbuilders regarding the construction of a new steamer for its express service to New York The company is now in a position to state that Messrs. John Brown & Company, Limited, Clydebank, have been selected as builders.

The Clyde Shipping Company, Limited, Glasgow, have placed an order with Messrs. D. & W. Henderson, Limited, Glasgow, for the construction of a passenger, cattle and cargo steamer measuring 270 ft. in length, 37 ft. beam, and 18 ft. moulded depth, with a gross tonnage about 1,500. The builders will supply the propelling machinery, consisting of triple-expansion engines.

Messrs. Lithgows, Limited, Port Glasgow, have launched the cargo steamer "Benavon," which they have built for the Ben Line of Steamers, Limited, Leith. The vessel, which is designed to carry about 9,500 tons deadweight, is 440 ft. over-all length, 56 ft. in extreme breadth and 31½ in. in moulded depth. Direct-acting triple-expansion engines with multi-tubular cylindrical boilers will be installed by Messrs. Rankin & Blackmore, Greenock.

The Foundry Plant & Machinery, Limited, of 100, Wellington Street, Glasgow, announce that amongst their sales for the last month are included two motive machines; one of these, a 17-ft. 6-in. radius arm machine, is for an East Midlands firm who already own and operate two portable machines; the other, a 20-ft. radius arm motive machine, is for a well-known Glasgow firm. This latter machine is the largest radius they have yet undertaken, and is about the extreme limit of the motive model.

In fixing wages for the Rhineland Westphalia iron and steel industry, the official arbitration court for the district has adopted a new principle. Under the terms of the award the wage bill of the industry will be reduced by 10 per cent., but at the same time it is stipulated that the owners must lower the selling price of iron and steel by an equal amount. Owing to its experimental character, the award, which is evidently a measure intended to create employment, will only remain valid until May 31, 1931.

The Unopposed Bill Committee of the House of Lords have passed the Bill promoted by the Great Western Railway Company authorising the construction of a second entrance to their Swansea Docks on the western side of the present entrance. This scheme, which has already been sanctioned by the House of Commons, was put forward by the railway company after the rejection of the original proposal for a second entrance. The works are estimated to cost about £1,000,000, and their construction will be entirely on the company's own property.

The Board of the Wigston Foundry, South Wigston, near Leicester, has been reorganised, with Mr. S. L. Wright as chairman and Messrs. Guy Barrett and W. Ralph Bates as managing directors. The programme of modernisation of their works, including the addition of new machine shops, is now in progress, and will enable the company—already well known for its grate-stove engineering and street castings—to undertake work of all classes. They will also manufacture the Elkington patent non-rocking man-hole cover, which combines with this important feature lightness, water tightness and great strength.

A tour of the works and shipyards of Messrs. Sir W. G. Armstrong, Whitworth & Company, Limited, on Tyneside, discloses an encouraging state of affairs. The three shipyards at Low Walker and Willington Quay are well supplied with work, having 10 vessels on the stocks, all oil tankers. In addition, a floating whaling factory, recently launched, is alongside the yards, fitting out. At the Scotswood works there are 70 locomotives of various types under construction for home and foreign railways, including 20 of exceptional size and weight for the Argentine. In the marine-engineering department 10 sets of Armstrong-Sulzer Diesel engines are in hand, in addition to two sets of steam reciprocating engines.

During the debate on the Finance Bill in the House of Commons recently Mr. Snowden, the Chancellor of the Exchequer, mentioned four iron and steel companies which he asserted had paid away in dividends their profits during the post-war years of prosperity instead of conserving them for future improvements and developments. Mr. Snowden quoted the rates of dividend which he asserted were paid by these companies during the three years immediately following the war, and went on to declare that the Consett & Ebbw Vale companies, together with Messrs. Baldwins and John Brown & Company, were now in a condition of inefficiency, and that it was impossible for them to compete successfully in the markets of the world. Mr. Edward J. George, general manager of the Consett Iron Company, Limited, in a letter to "The Times," points out how his company has been misrepresented. He states that since 1918 the Consett Company has expended between £5 and £6 million on new plant, and that of this amount actually more than one-half has been provided from the company's own reserves of profits. These developments include two of the largest coke ovens and by-product plants in England; modern silica works making gasworks retorts and coke-oven shapes; new steelmaking works of modern type; an up-to-date plate-mill plant, together with an improved plant for rolling steel sections of every kind; electrical equipment for collieries and works; and 1,500 dwelling houses for workpeople. Mr. George contends that nothing that could be done has been left undone to make the plant efficient, and at the same time to provide for the comfort of the workpeople. Figures of actual dividends paid in the years mentioned show that in the case of the other three companies referred to Mr. Snowden was also very wide of the mark in his statement, the distributions made averaging only about half the rates stated by the Chancellor of the Exchequer.

New Companies.

Non-Ferreous Casting Company (Birmingham), Limited, 43, Cannon Street, Birmingham.—Capital £100. Directors: W. Astley and J. Henderson.

Irons Brothers, Limited, The Factory, St. Breock, Cornwall.—Capital £5,000. General and hydraulic engineers, etc. Directors: W. E., J. L. and E. C. Irons.

Charles Jones (Ninian Foundry), Limited, Ninian Foundry, East Moors, Cardiff.—Capital £5,000 in £1 shares. Directors: C. E. Jones (chairman) and G. F. B. Box.

George Tabbron, Limited, 180, Stockport Road, Ardwick, Manchester.—Capital £800 in £1 shares. Engineers and brass founders, etc. Directors: G. Tabbron, J. Ayrton and C. Taylor.

International Standardisation Congress.—At the International Standardisation Congress now sitting 17 nations are represented by 36 delegates. At a recent meeting a proposal was discussed, submitted by the Dutch group, for the standardisation of rivets.

Personal.

Sir Samuel Roberts, Bt., M.P., has been elected a member of the Cutlers' Company.

Mr. Basil Mott, the president of the Institute of Civil Engineers, has been created a baronet.

Mr. J. H. Royce, of Messrs. Rolls Royce, Limited, Derby, has had the honour of a baronetcy conferred upon him.

Mr. Eric Greaves, of Kempfield House, Knottingley, Yorks, has been appointed assistant West Yorkshire representative of Messrs. General Refractories, Limited, Sheffield.

Mr. Nathaniel Martin has been appointed general manager of the Midland branch works of Messrs. Baldwins, Limited, in succession to the late Colonel D. E. Williams.

Mr. A. Corker, managing director of the Midland Iron Company, Rotherham, has been elected chairman of the South Yorkshire Bar Iron Association, in succession to Mr. H. C. Else, who has resigned.

Mr. V. G. Crittall, of Messrs. Crittall Manufacturing Company, Limited, engineers and founders of Braintree, Essex, has been the recipient of a Knighthood on the occasion of the recent King's Birthday Honours List.

Mr. H. A. Schwartz, the manager of the Research Department of the National Malleable & Steel Castings Company, of Cleveland, has been awarded the John A. Penton Gold Medal of the American Foundrymen's Association. He is the author of "American Malleable Cast Iron."

Mr. Lewis C. Ord, the vice-chairman and managing director of Messrs. William Beardmore & Company, Limited, has resigned from the board of the company. Mr. Ord has been a member of the board for some years, and took a prominent part in the reorganisation of the share and loan capital, and in the various rearrangements at the works.

Wills.

Raynes, T., Sheffield, cutlery manufacturer	£5,447
Smith, J. C. J., Edinburgh, a director of the Camelon Iron Company, Limited	£10,736
Unwin, M., director and works manager of John Brown & Company, Limited, Sheffield	£18,804
Carmichael, J. D., South Shields, managing director of Messrs. Carmichael Bros., Limited, ironfounders	£4,289

Reports and Dividends.

John Brown & Company, Limited.—Net profit, £24,184; brought in, £90,925; carried forward, £115,109.

Merry & Cuninghame, Limited.—The 7 per cent. cumulative preference dividend due on May 31 will not be paid.

Anderston Foundry Company, Limited.—Net profit, £11,032; brought in, £2,188; dividend of 8s. per £5 share; balance, £3,920.

Stanton Ironworks Company, Limited.—Final dividend of 6 per cent. on the ordinary shares, making 10 per cent., tax free, for the year.

Stewarts & Lloyds of South Africa, Limited.—Final dividend of 3 per cent., making 6 per cent. for the year, on the first cumulative preference shares.

Park Gate Iron & Steel Company, Limited.—Profit, £62,007; depreciation, £20,000; debit balance brought in, £37,772; credit balance carried forward, £4,235.

Allied Ironfounders, Limited.—Dividend on the 7 per cent. cumulative preference shares for the year ended March 31 last, but no distribution on the ordinary shares.

Whessoe Foundry & Engineering Company, Limited.—Profit, £37,324; brought in, £5,625; depreciation, £4,965; dividend of 17½ per cent.; carried forward, £6,593.

Siemens Bros. & Company, Limited.—Profit, £314,464; brought in, £313,360; debenture interest and redemption, £67,439; dividend of 10 per cent. on the cumulative preference shares, £55,000; total ordinary dividend of 7½ per cent., £166,875; carried forward, £338,510.

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THE WEAKNESS IN CUPOLA LININGS

is the joints of the brickwork. It is folly to pay money for good quality Firebricks without purchasing the best refractory for jointing the bricks. **Fireclay is not good enough.** You must have a material which is not only refractory but very strong, and will prevent fluxing at the brick joints and a constant moving of the bricks when contracting or expanding.

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THE HIGH TEMPERATURE, FIRE-RESISTING CEMENT, WHICH WILL SET COLD WITHOUT THE APPLICATION OF ANY HEAT WHATEVER

IS IDEAL FOR THIS WORK

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Iron and Steel Markets.

Pig-Iron.

MIDDLESBROUGH.—Although business in the Cleveland iron market, on the whole, has of late been confined mostly to small tonnages, it is satisfactory to note that in the aggregate such orders are in sufficient volume to check accumulations of stocks, and also to inspire a more confident feeling of impending improvement in the near future. For months buyers have been hanging back, and even now they are not prepared to buy forward. All orders placed for pig-iron are for early delivery, and despite the apparently firm front of the Cleveland ironmasters, consumers appear to think that another fall in prices will come. However, they cannot wait for ever. Iron is wanted for current needs, and that explains the bulk of the sales recently made. A few export orders are reported, but sales abroad show no substantial expansion, and most of the local blast furnaces are still employed on the production of iron for adjacent steelworks. Current quotations remain firm, as follow:—No. 1 Cleveland foundry iron, 70s. per ton; No. 3 G.M.B., 67s. 6d.; No. 4 foundry, 66s. 6d.; No. 4 forge, 66s. per ton.

The market for East Coast hematite continues in a most unsatisfactory condition, makers confronted with heavy accumulations of stocks being anxious to unload at a loss rather than hold on in the hope of an early renewal of demand. Consequently price-cutting is becoming the general practice, and although 74s. is accepted for small parcels, concessions are readily obtainable for sizeable tonnages. On the North-West Coast, Bessemer mixed numbers are quoted at from 72s. to 73s. per ton, delivered works.

LANCASHIRE.— Buying interest in local markets for foundry pig has again been small, and orders have not only been few in number, but have not in the aggregate been at all important from the tonnage point of view. Prices remain as previously quoted, with No. 3 Derbyshire and Staffordshire still at 77s. per ton and Scottish brands at about 95s., all per ton delivered local stations.

THE MIDLANDS.—It was decided at last week's meeting of ironmasters in the district that there should be no change in prices for the time being. It is early yet to judge what will be the effect of this decision, but it may bring forward a few contracts, as consumers have been holding back for some months past in the hope of a lower level of prices. Current quotations are, therefore, undisturbed, still ruling as follow:—Northants No. 3, 75s.; Derbyshire No. 3, 78s.; and No. 3 North Staffordshire, 78s.; all per ton delivered local stations.

SCOTLAND.—There is no improvement to report in the state of the Scottish pig-iron market. The increasing imports of Indian iron, both foundry and basic, are having a very depressing effect on the pig-iron makers in this district, who are unable to compete with the prices being taken for this iron. The quality of the iron is excellent, and users are quite prepared to take repeat lots. There is no change in the official price of Scotch iron at 78s. for No. 3 foundry f.o.t. furnaces.

Finished Iron.

At Birmingham this week there was only a moderate demand for most descriptions of material, while the prices of the various grades of finished iron have undergone no change. Marked bars, for which there continues to be a fairly satisfactory demand, are quoted at £12 10s. at works. There is no improvement in the demand for crown and nut and bolt iron. The makers are quite unable to collect sufficient tonnage to keep their mills going regularly, and there is much competition and price-cutting for what business there is emanating from the consumers and stockholders. Crown iron is offered at between £10 and £10 7s. 6d., and nut and bolt iron at from £9 upwards.

Steel.

At Sheffield this week business in the market for steel and semi-products is reported quiet, conditions, it may be added, fairly general throughout the trade. Both acid and basic billets are in slow request. The output of open-hearth steel is falling away, being now smaller than at any time this year. Sales of special steels are moderately good, but the requirements of the motor-car industry show a sharp shrinkage. Makers of tool steel are fairly well placed for orders, and the arrival of Government orders during the last four days is welcome. Business from India is decreasing. Prices are unchanged. The tinplate market shows an easier tendency, 18s. to 18s. 3d. being the current quotation for coke quality, net cash, f.o.b. Welsh ports.

Scrap.

Reports from the various centres of the foundry scrap trade show little or no improvement from a business standpoint, and at Tees-side this week there were few buyers of ordinary heavy cast-iron material at 58s. per ton, with heavy machinery quality at 61s. per ton. In the Midlands no great alteration has taken place in the price of cast-iron scrap, although the demand is poor; 65s. to 67s. 6d. is offered for machinery cast-iron scrap and 55s. for light metal. In Scotland, machinery cast-iron scrap is unchanged at around 67s. 6d., ordinary cast iron at 62s. 6d. to 63s. 6d., and light cast iron at 52s. 6d. The above prices are all per ton delivered f.o.t. consumers' works.

Metals.

Copper.—The position in the market for warrant copper has developed a slightly weaker tendency, prices again showing a decline. Buying has been only in moderate volume of late, consumers having bought fairly extensively during the recent period of low prices, and, having now stocks in hand, are again adopting the policy of accepting only sufficient metal to cover their current requirements. The American copper exporters are hoping to stabilise the price at the present level of 13 c., but, while this figure is maintained, it is not likely that consumers, in this country at least, will engage in forward commitments to any considerable extent.

Closing quotations :—

Cash.—Thursday, £53 17s. 6d. to £54; Friday, £54 to £54 2s. 6d.; Monday, £53 15s. to £53 17s. 6d.; Tuesday, £53 5s. to £53 7s. 6d.; Wednesday, £52 17s. 6d. to £53.

Three Months.—Thursday, £54 to £54 2s. 6d.; Friday, £54 to £54 2s. 6d.; Monday, £53 15s. to £53 17s. 6d.; Tuesday, £53 10s. to £53 12s. 6d.; Wednesday, £53 5s. to £53 7s. 6d.

Tin.—The recent further decline in standard cash tin resulted from market anticipation of adverse figures in the statistical returns for May, and that another increase in visible supplies may be disclosed. It is now generally acknowledged that the present method of restriction is having no effect on the market, and the possibility of the producers introducing some other methods is being freely discussed. Producers generally will probably agree as to the unsatisfactory working of the present method and will probably evolve a fresh scheme.

Official closing prices :—

Cash.—Thursday, £141 2s. 6d. to £141 5s.; Friday, £140 12s. 6d. to £140 15s.; Monday, £138 15s. to £138 17s. 6d.; Tuesday, £136 17s. 6d. to £137; Wednesday, £135 to £135 5s.

Three Months.—Thursday, £143 2s. 6d. to £143 5s.; Friday, £142 12s. 6d. to £142 15s.; Monday, £140 12s. 6d. to £140 15s.; Tuesday, £138 15s. to £138 17s. 6d.; Wednesday, £136 17s. 6d. to £137.

Spelter.—The spelter market has remained fairly steady, with comparatively small fluctuations in values and not a great deal of business in the market. The demand for the metal still remains below the normal. The galvanisers are taking only small quantities at the moment, and until the consuming industries become more active, a better demand for spelter cannot materialise.

Daily fluctuations :—

Ordinary.—Thursday, £16 16s. 3d.; Friday, £16 15s.; Monday, £16 12s. 6d.; Tuesday, £16 8s. 9d.; Wednesday, £16 7s. 6d.

Lead.—This market has remained very steady, the tendency of prices being, if anything, in a downward direction. Generally, the position of the market shows little change. Supplies are offering in excess of current requirements, but the low level of prices should stimulate demand.

The week's prices have been :—

Soft Foreign (Prompt).—Thursday, £18; Friday, £18; Monday, £17 15s.; Tuesday, £17 18s. 9d.; Wednesday, £17 17s. 6d.

Students' Corner.

Q.—Do all grades of cast iron contract the same?

A.—A dead soft open-grain iron, which usually contains a high silicon content (3 per cent.), high carbon (4 per cent.), low sulphur (0.3 per cent.), approximating to a No. 1 grade, will not contract as much as a No. 4 grade, which contains a less amount of carbon and silicon, and more sulphur; also a white iron, which again contains less carbon and less silicon, and an increase in sulphur, will contract more than a No. 4 grade.

To put these three grades into inches per foot, they would roughly be, in the order given, $\frac{1}{12}$, $\frac{1}{8}$ and $\frac{1}{4}$ in. This fact can be demonstrated if a 12-in. cube is poured with each of these grades of iron and afterwards measured.

Q.—Does thickness of section in cast iron compared with thin section vary in contraction?

A.—From the author's experiences the answer must be in the positive. For instance, a number of flanged cylindrical castings, 42 in. dia. by 10 ft. long, the flanges being heavily bracketed, were being made. The thickness of these castings varied from 1½ to 2¾ in. The thick castings came out a little less than full pattern size, whilst the thin castings, *i.e.*, 1½ in. thick, worked out at an ⅛ in. per ft. A similar experience occurred when engaged on some locomotive twin cylinders of a heavy chubby type. In these cases the contraction was altered to suit the castings.

Q.—Apart from grade of iron, has the rate of cooling any influence in varying contraction?

A.—Naturally, a thin section will contract quicker and probably more than a thick section.

Q.—Is it possible, then, where various thicknesses exist in the same pattern, that various rates of contraction take place in the same casting at the same time during the period of solid cooling?

A.—It is more than possible; it actually occurs, often causing cracks and ruptures in castings.

Q.—Can solid contraction be controlled during the cooling period?

A.—To some extent this may be done, but it is difficult and uncertain. Where the heavy parts are easily accessible these may be bared with the object of equalising the cooling.

Q.—If large castings are liable to fracture, due to contraction variables, what is the remedy?

A.—Improvement in design, and, in many cases, castings with a great disparity in thickness that cannot be avoided, may be with advantage made in two or more parts with provision for assembling.

Q.—Does not that answer depend upon the engineer?

A.—Undoubtedly, but if these points of weakness in design are not shown to the engineer one cannot expect him to know. A sensible engineer will consent to a reasonable alteration suggested by the foundryman when he is satisfied a more reliable casting can be produced.

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CORE GUM
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WEEKLY PRICE CURRENT.

COPPER.

	£	s.	d.
Standard cash	52	17	6
Three months	53	5	0
Electrolytic	60	10	0
Tough	59	5	0
Best selected	59	15	0
Sheets	87	0	0
India	72	0	0
Wire bars	61	7	6
Do. June	61	7	6
Do. July	61	7	6
Ingot bars	61	7	6
H.C. wire rods	63	7	6
Off. av. cash, May	53	5	0 5/8
Do., 3 mths., May	53	1	5 1/16
Do., Sttlmnt., May	53	4	2 1/16
Do., Electro, May	60	9	6 1/16
Do., B.S., May	59	10	3½
Do., wire bars, May	61	8	2 5/16
Solid drawn tubes			12½d.
Brazed tubes			12½d.
Wire			8½d.

BRASS.

Solid drawn tubes	11d.
Brazed tubes	12½d.
Rods, drawn	10½d.
Rods, extd. or rlld.	6½d.
Sheets to 10 w.g.	9½d.
Wire	9½d.
Rolled metal	8½d.
Yellow metal rods	6½d.
Do. 4 × 4 Squares	7½d.
Do. 4 × 3 Sheets	7½d.

TIN.

	£	s.	d.
Standard cash	135	0	0
Three months	136	17	6
English	136	0	0
Bars	140	0	0
Straits	138	17	6
Australian	138	2	6
Eastern	142	7	6
Banca	142	17	6
Off. av. cash, May	144	18	0 3/16
Do., 3 mths., May	146	15	10 11/16
Do., Sttlmt., May	144	17	6

SPELTER.

	£	s.	d.
Ordinary	16	7	6
Remelted	15	12	6
Hard	13	15	0
Electro 99.9	18	15	0
English	16	17	6
India	15	0	0
Zinc dust	22	0	0
Zinc ashes	4	10	0
Off. aver., May	18	1	11⅛
Aver., spot, May	16	12	9 2/32

LEAD.

	£	s.	d.
Soft foreign ppt.	17	17	6
English	19	10	0
Off. average, May	17	16	6¼
Average spot, May	17	15	10 10/16

ZINC SHEETS, &c.

	£	s.	d.
Zinc sheets, English	27	0	0
Do. V.M. ex-whf.	25	10	0
Rods	30	0	0
Boiler plates	22	0	0
Battery plates	24	0	0

ANTIMONY.

	£	s.	d.
Special brands, Eng.	40	0	0
Chinese	26	15	0
Crude	20	0	0

QUICKSILVER.

	£	s.	d.
Quicksilver	22	10	0

FERRO-ALLOYS AND STEEL-MAKING METALS.

Ferro-silicon—	
25%	£7 17 6
45/50%	£11 10 0
75%	£18 10 0
Ferro-vanadium—	
35/50%	12/9 lb. Va.
Ferro-molybdenum—	
70/75% c. free	4/2 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£16 0 0
Ferro-tungsten—	
80/85%	2/10 lb.
Tungsten metal powder—	
98/99%	3/1 lb.
Ferro-chrome—	
2/4% car.	£30 10 0
4/6% car.	£23 7 6
6/8% car.	£22 10 0
8/10% car.	£22 0 0
Ferro-chrome—	
Max. 2% car.	£33 10 0
Max. 1% car.	£37 17 6
Max. 0.70% car.	£39 15 0
70% carbon-free	11d. lb.
Nickel—99% cubes, or pellets	£175 0 0
Ferro-cobalt	9/6 lb.
Aluminium 98/99%	£95 0 0
Metallic chromium—	
96/98%	2/7 lb.
Ferro-manganese (net)—	
76/80% loose	£11 15 0
76/80% packed	£12 15 0
76/80% export	£11 10 0
Metallic manganese—	
94/96% carbonless	1/4 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL.

Finished bars, 14% tungsten	£0 2 2
Finished bars, 18% tungsten	£0 3 0

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ½ in. to ¼ in.	3d. lb.
Do., under ¼ in. to 3/16 in.	1/- lb.
Flats, ½ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ½ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP.

	£	s.	d.		£	s.	d.
South Wales—							
Heavy steel	2	17	6	to	3	0	0
Bundled steel and shrngs.	2	14	0	to	2	17	0
Mixed iron and steel	2	14	0	to	2	15	0
Heavy cast iron	2	16	0	to	2	17	0
Good machinery for foundries	2	17	0	to	2	18	0
Cleveland—							
Heavy steel					2	10	0
Steel turnings					2	6	6
Cast-iron borings					2	1	0
Heavy forge					3	12	0
W.I. piling scrap					3	7	6
Cast-iron scrap	2	18	0	to	3	1	0
Midlands—							
Ord. cast-iron scrap					3	5	0
Heavy wrought					3	5	0
Steel turnings					1	12	6
Scotland—							
Heavy steel					2	15	0
Ordinary cast iron					3	3	0
Engineers' turnings					2	5	6
Cast-iron borings					2	7	6
Wrought-iron piling					3	18	6
Heavy machinery					3	8	6

London—Merchants' buying prices delivered yard.

	£	s.	d.
Copper (clean)	47	0	0
Brass	35	0	0
Lead (less usual draft)	15	10	0
Tea lead	11	10	0
Zinc	9	0	0
New aluminium cuttings	60	0	0
Braziery copper	44	0	0
Gunmetal	44	0	0
Hollow pewter	110	0	0
Shaped black pewter	82	0	0

PIG-IRON.

(f.o.t. unless otherwise stated.)

N.E. Coast—	
Foundry No. 1	70/-
Foundry No. 3	67/6
Foundry No. 4	66/6
Forge No. 4	66/-
Hematite No. 1	74/6
Hematite M/Nos.	74/-
N.W. Coast—	
Hem. M/Nos. d/d Glas.	85/6
,, d/d Birm.	91/6
Midlands—	
Staffs. common*	—
,, No. 4 forge*	73/6
,, No. 3 fdry.*	78/6
Shrops. basic	—
,, Cold blast, ord.	—
,, ,, roll iron	—
Northants forge*	70/-
,, fdry. No. 3*	75/-
Derbyshire forge*	73/6
,, fdry. No. 3*	78/6
,, basic*	—
Scotland—	
Foundry No. 1	80/6
,, No. 3	78/-
Hem. M/Nos.	81/-
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	73/6
Lincs. forge	70/-
,, fdry. No. 3	75/-
E.C. hematite	88/-
W.C. hematite	88/-
Lincs. (at furnaces)—	
Forge No. 4	—
Foundry No. 3	—
Basic	—
Lancashire (d/d eq. Man.)—	
Derby forge	72/-
,, fdry. No. 3	77/-
Staffs foundry No. 3	77/-
Dalzell, No. 3 (special)	105/- to 107/6
Summerlee, No. 3	95/-
Glengarnock, No. 3	—
Gartsherrie, No. 3	95/-
Monkland, No. 3	95/-
Shotts, No. 3	95/-

*d/d Black Country dist.

FINISHED IRON AND STEEL.

Usual District deliveries for iron; delivered consumers' station for steel.

Iron—	£	s.	d.		£	s.	d.
Bars (cr.)	10	5	0	to	10	15	0
Nut and bolt iron	9	0	0	to	9	7	6
Hoops					10	15	0
Marked bars (Staffs) f.o.t.					12	10	0
Gas strip					10	15	0
Bolts and nuts, ¾ in. × 4 in.					15	5	0
Steel—							
Ship plates	8	15	0	to	8	17	6
Boiler plts.	9	15	0	to	10	10	0
Chequer plts.					10	12	6
Angles					8	7	6
Tees					9	7	6
Joists					8	10	0
Rounds and squares, 3 in. to 5½ in.					9	7	6
Rounds under 3 in. to ¾ in. (Untested)					8	0	0
					and upwards		
Flats—8 in. wide and over					8	12	6
,, under 8 in. and over 5 in.					8	17	6
Rails, heavy					8	10	0
Fishplates					12	0	0
Hoops (Staffs)	9	5	0	to	9	15	0
Black sheets, 24 g.					9	15	0
Galv.cor.shts., 24g.					11	17	6
Galv. fencing wire, 8g. plain					12	0	0
Billets, soft	6	0	0	to	6	10	0
Billets, hard	7	10	0	to	8	0	0
Sheet bars	5	15	0	to	6	5	0
Tin bars	6	2	6	to	6	5	0

PHOSPHOR BRONZE.

	Per lb. basis.
Strip	1/1½
Sheet to 10 w.g.	1/2
Wire	1/3½
Rods	1/2½
Tubes	1/6½
Castings	1/1½

Delivery 3 cwt. free.
10% phos. cop. £40 above B.S.
15% phos. cop. £50 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	per lb.
Ingots for raising	9d. to 1/3
Rolled—	
To 9 in. wide	1/3 to 1/9
To 12 in. wide	1/3½ to 1/9½
To 15 in. wide	1/3½ to 1/9½
To 18 in. wide	1/4 to 1/10
To 21 in. wide	1/4½ to 1/10½
To 25 in. wide	1/5 to 1/11
Ingots for spoons and forks	9d. to 1/5½
Ingots rolled to spoon size	1/- to 1/8½
Wire round—	
3/0 to 10 G.	1/6½ to 2/1½

with extras according to gauge.

AMERICAN IRON AND STEEL.

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	19.76
No. 2 foundry, Valley	18.50
No. 2 foundry, Birm.	14.00
Basic	20.26
Bessemer	20.76
Malleable	20.76
Grey forge	19.76
Ferro-mang. 80%	94.00
O.-h. rails, h'y, at mill	43.00
Billets	33.00
Sheet bars	33.00
Wire rods	36.00
	Cents.
Iron bars, Phila.	2.12
Steel bars	1.75
Tank plates	1.70
Beams, etc.	1.70
Skelp, grooved steel	1.80
Skelp, sheared steel	1.80
Steel hoops	2.20
Sheets, black, No. 24	2.55
Sheets, galv., No. 24	3.20
Sheets, blue an'l'd, No. 13	2.15
Wire nails	2.15
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens).

Welsh foundry	27/6
,, furnace	17/6 to 22/6
Durham and Northumberland—	
,, foundry	14/6 to 15/-
,, furnace	14/6
Midlands, foundry	—
,, furnace	—

TINPLATES.

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 box	18/1½
,,	28×20 ,,	36/3
,,	20×10 ,,	26/4½
,,	18¾×14 ,,	19/1½
C.W.	20×14 ,,	16/6
,,	28×20 ,,	33/9
,,	20×10 ,,	23/6
,,	18¾×14 ,,	17/-
Terneplates	28×20	32/6 per box basis f.o.b.

SWEDISH CHARCOAL IRON & STEEL.

Pig-iron	£6	0	0	to	£7	10	0
Bars, hammered, basis	£17	10	0	to	£18	10	0
Bars and nail-rods, rolled, basis	£15	17	6	to	£16	15	0
Blooms	£10	0	0	to	£12	0	0
Keg steel	£32	0	0	to	£33	0	0
Faggot steel	£20	0	0	to	£24	0	0
Bars and rods dead soft, steel	£11	0	0	to	£14	0	0

All per English ton, f.o.b. Gothenburg.

TUBES AND FITTINGS.

Over ½ in. up to 6 in.

	Tubes.	*Fittings.*
Gas	62½%	47½%
Water ..	58½%	42½%
Steam ..	55%	37½%

W.I. 12½% extra.

DAILY FLUCTUATIONS.

Standard Copper (cash).

		£	s.	d.	
May	29 ..	53	17	6	inc. 2/6
,,	30 ..	54	0	0	,, 2/6
June	2 ..	53	15	0	dec. 5/-
,,	3 ..	53	5	0	,, 10/-
,,	4 ..	52	17	6	,, 7/6

Electrolytic Copper.

		£	s.	d.	
May	29 ..	60	10	0	No change
,,	30 ..	60	10	0	,, ,,
June	2 ..	60	10	0	,, ,,
,,	3 ..	60	10	0	,, ,,
,,	4 ..	60	10	0	,, ,,

Standard Tin (cash).

		£	s.	d.	
May	29 ..	141	2	6	No change
,,	30 ..	140	12	6	dec. 10/-
June	2 ..	138	15	0	,, 37/6
,,	3 ..	136	17	6	,, 37/6
,,	4 ..	135	0	0	,, 37/6

Tin (English ingots).

		£	s.	d.	
May	29 ..	142	5	0	inc. 5/-
,,	30 ..	141	15	0	dec. 10/-
June	2 ..	139	15	0	,, 40/-
,,	3 ..	138	0	0	,, 35/-
,,	4 ..	136	0	0	,, 40/-

Zinc Sheets (English).

		£	s.	d.	
May	29 ..	27	0	0	No change
,,	30 ..	27	0	0	,, ,,
June	2 ..	27	0	0	,, ,,
,,	3 ..	27	0	0	,, ,,
,,	4 ..	27	0	0	,, ,,

Spelter (ordinary).

		£	s.	d.	
May	29 ..	16	16	3	No change
,,	30 ..	16	15	0	dec. 1/3
June	2 ..	16	12	6	,, 2/6
,,	3 ..	16	8	9	,, 3/9
,,	4 ..	16	7	6	,, 1/3

Lead (English).

		£	s.	d.	
May	29 ..	19	10	0	No change
,,	30 ..	19	10	0	,, ,,
June	2 ..	19	5	0	dec. –
,,	3 ..	19	10	0	inc. 5/-
,,	4 ..	19	10	0	No change

AVERAGE MONTHLY PRICES OF UNMARKED BARS (SOUTH STAFFS).

—	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1897	6 0 0	6 0 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 0 0	6 0 0	6 3 9
1898	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 5 0	6 5 0	6 5 0	6 10 0	6 10 0	6 2 11
1899	3 10 0	6 15 0	6 15 0	6 15 0	7 0 0	7 0 0	7 10 0	7 10 0	8 10 0	9 0 0	9 0 0	9 10 0	7 12 11
1900	10 0 0	10 10 0	10 10 0	10 10 0	10 15 0	10 15 0	10 5 0	10 5 0	10 5 0	9 10 0	8 15 0	8 15 0	10 1 3
1901	8 0 0	7 10 0	7 5 0	7 0 0	6 10 0	6 10 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 15 0	6 17 11
1902	7 0 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 0	6 10 0	6 15 0	6 15 0	6 15 0	6 10 0	6 10 0	6 13 4
1903	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 10 0	6 7 0	6 5 0	6 9 4
1904	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 5 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 0 0	6 2 11
1905	6 5 0	6 5 0	6 0 0	5 17 6	5 15 0	5 15 0	5 15 0	6 0 0	6 0 0	6 5 0	6 15 0	6 15 0	6 1 10½
1906	7 0 0	7 5 0	7 5 0	7 5 0	6 17 6	6 15 0	6 12 6	6 10 0	6 10 0	6 12 6	6 16 3	7 3 9	6 17 8½
1907	7 3 9	7 5 0	7 5 0	7 5 0	7 5 0	7 7 6	7 5 0	7 7 6	7 7 6	7 7 6	7 7 6	7 5 0	7 5 11
1908	7 2 6	7 0 0	7 0 0	7 0 0	6 15 0	6 7 6	6 5 0	6 2 6	6 2 6	6 2 6	6 2 6	6 0 0	6 10 0
1909	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 0 0	6 0 0	5 17 6	6 0 0	6 2 6	6 2 6	5 17 6	5 19 9½
1910	6 2 6	6 3 4½	6 7 6	6 7 6	6 7 6	6 7 6	6 6 6	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 7
1911	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 5 0	6 10 0	6 12 6	6 16 6	6 7 0
1912	6 18 9	7 1 10	7 2 6	7 8 9	7 18 0	8 0 7	8 2 6	8 3 6	8 5 0	8 6 3	8 7 6	8 8 9	7 17 0
1913	8 11 6	8 10 7½	8 10 0	8 8 1½	8 2 0	8 0 0	7 17 6	7 11 6	7 8 9	7 5 6	6 18 1½	6 17 6	7 16 9
1914	6 17 6	6 15 7½	6 12 6	6 10 0	6 10 0	6 10 0	6 10 0	7 11 10½	8 0 0	7 12 6	7 5 7½	7 6 3	7 1 0
1915	7 11 6	8 5 11	8 8 9	9 6 0	10 3 2	10 19 2	11 12 6	11 13 1½	11 13 9	11 14 3	12 1 10½	13 0 9	10 6 0
1916	13 7 6	13 10 8	13 12 9½	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 3 9½
1917	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0	13 15 0
1918	13 15 0	13 17 3	13 17 6	13 17 6	13 17 6	13 17 6	13 17 6	14 15 0	14 15 0	14 15 0	14 15 0	14 15 0	14 4 5½
1919	15 10 0	16 5 0	17 15 0	17 15 0	20 15 0	21 0 0	21 0 0	22 0 0	22 0 0	22 0 0	22 7 6	22 12 6	20 1 8
1920	24 7 6	24 10 0	25 10 0	27 10 0	29 5 0	31 0 0	31 10 0	31 10 0	31 10 0	31 10 0	31 10 0	29 7 6	29 1 8
1921	26 17 3	25 0 0	23 0 0	21 0 0	19 0 0	18 5 0	16 0 0	16 0 0	15 14 0	14 0 0	13 6 8	13 0 0	19 4 5
1922	13 0 0	12 3 9	11 14 0	11 11 10½	11 5 0	11 3 6	11 2 6	11 5 0	10 17 2½	10 16 3	10 13 0	10 12 6	11 7 0½
1923	10 16 10½	11 3 1½	12 2 6	12 8 9	12 11 6	12 1 3	11 15 11½	11 15 0	11 15 0	11 15 0	12 13 6	12 8 3	11 18 10½
1924	12 9 6	12 10 0	12 10 0	12 15 7½	12 17 6	12 17 6	12 17 6	12 17 6	12 17 6	12 14 0	12 12 6	12 12 6	12 14 3½
1925	12 12 6	12 12 6	12 12 6	12 12 6	12 12 6	12 7 6	12 7 6	12 4 6	12 4 6	11 18 6	11 13 9	11 13 0	12 6 2½
1926	11 7 9½	11 5 0	11 5 0	11 5 0	11 3 9	11 3 9	11 5 0	12 0 0	13 0 0	*	15 7 6	12 10 0	12 0 2
1927	12 6 3	12 2 6	11 14 0	11 0 0	10 18 9	10 13 6	10 12 6	10 5 0	9 16 0	9 15 0	9 13 9	9 12 9	10 14 2
1928	9 12 6	9 12 6	9 11 0	9 10 0	9 8 4	9 5 0	9 5 0	9 5 0	9 5 0	9 5 0	9 3 6	9 1 3	9 7 0
1929	9 0 0	9 2 6	9 5 7½	9 9 4½	9 10 0	9 17 6	10 2 6	10 2 6	10 2 6	10 0 6	10 3 9	10 5 7½	9 15 2½
1930	10 7 6	10 7 6	10 7 6	10 6 10½	10 6 3	10 5 11½	—	—	—	—	—	—	—

* No quotations available owing to strike.

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WANTED, Working Foreman for small Foundry near London; good prospects for reliable man.—Details to Box 532, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

TRAVELLER required for Brass Foundry in London. State terms.—Box 528, Offices of THE FOUNDRY TRADE JOURNAL, 49, Wellington Street, Strand, London, W.C.2.

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Portable Pumping Sets, comprising 4-h.p. Oil Engine and 6-in. x 6-in. Horizontal Pump; approx. 2,500 galls. per hr., on 4 road wheels.

Horizontal Duplex Piston Pattern Pumps. All sizes.

2-ft. 0-in. Gauge 20-h.p. "SIMPLEX" PETROL LOCOMOTIVES, 2-cylinder "Dorman" Engine.

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COCHRAN BOILER, 11 ft. 3 in. x 5 ft. 0 in., working steam pressure 100 lbs. per sq. in.

FOUNDRY LADLES, various types and sizes.

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Foundry Consultants and Advisors. Analyses and Testing carried out at low rates at The Laboratories, St. Peter's Close, Sheffield.

MISCELLANEOUS—*Continued.*

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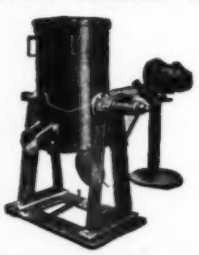

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